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China Report

ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT--31

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CONTENTS

NATIONAL POLICY

SHANDONG SETS RECORDS IN ENERGY PRODUCTION

OW271145 Beijing XINHUA in English 1127 GMT 27 Aug 84

[Text] Jinan, 27 August (XINHUA)--East China's coastal province of Shandong--a new energy base--turned out 26.44 million tons of coal, 12.26 million tons of crude oil, and generated 13.37 billion kilowatt-hours of electricity in the first 7 months of this year, all of them all-time records for the same period for the province.

Last year, Shandong's coal output reached 43.85 million tons, ranking sixth in the country. It was 24.5 times the figure of 1949 when the People's Republic came into existence.

There are more than 110 coal mines in operation in the province. They have a combined capacity of 35.87 million tons a year. Of these, 10 are capable of turning out more than 1 million tons each.

The province has produced 729 million tons of coal in the past 35 years and is a major coal supplier to iron and steel plants in Shanghai, Wuhan, Maanshan and other south China cities.

In 1983, Shandong's power generating capacity came to more than 4.18 million kilowatts and power output amounted to 21.82 billion kilowatt-hours--32 times and 104 times the 1949 figures, respectively.

In early post-liberation years, Shandong had only 13 small power plants with a combined generating capacity of 130,800 kilowatts. Now, large thermal power plants have been built in large and medium-sized cities and major coal-producing centers throughout the province, with 20 generating units each surpassing 100,000 kilowatts. A unified power grid has been erected, ensuring electricity supply even to remote mountain villages in the province.

The Shengli oilfield, China's second largest, produced 18.37 million tons of crude oil in 1983, accounting for more than one-sixth of the national total. It has pumped out 219 million tons of crude oil since development started in 1964. Its present-average 2-day output now exceeds the nation's yearly total for 1949. Shengli has exported 22.66 million tons of crude oil in the past 20 years. It has also produced over 13 billion cubic meters of natural gas in the same period.

Shandong's energy industry, though having made marked headway in the past 5 years, is expected to expand further, against the national background of putting emphasis on exploitation of energy resources.

The Yanzhou coal field, one of the state's key projects, is speeding up its development. One of its coal mines with a designed annual capacity of 3 million tons has already gone into operation and a coal dressing plant with the same capacity has been completed.

At present, six large power plants are either under construction or due to start. Two of them have a designed generating capacity of 2.4 million kilowatts each and the rest 1.2 million kilowatts each.

In the first half of this year, the Shengli oilfield struck seven high-yield wells each with a daily output of more than 1,000 tons. With 120,000 workers, the Shengli oilfield is striving to speed up its development.

CSO: 4010/135

NATIONAL POLICY

ATTEMPT TO STREAMLINE MINING, SHIPPING, AND SALES OF COAL NOW PAYING OFF

Beijing RENMIN RIBAO in Chinese 11 Sep 84 p 1

[Text] The change to one "account book" for the production, shipping, and sale of coal is already showing results. In the first half of this year, the nation's unified distribution coal supplied more than 189,860,000 tons, some 10,400,000 tons more than the corresponding period of 1983, or an increase of 5.8 percent.

For quite some time, due to the keeping of separate "account books" by the production, shipping, and distribution departments, a situation of mutual disjointedness had existed. This year, these three sectors have been joined, combining the three "account books" into a single one, effecting a unified and planned arrangement for coal production, shipping, and sales. The results of this change are:

1) Smooth completion of coal supply contracts for the first 6 months of the year to provinces, cities, and autonomous regions;

2) completion or overfulfillment of the coal supply plan for such big consumers as the three cities of Beijing, Tianjin, and Shanghai, railroad locomotives, and the major steel mills of the Ministry of Metallurgical Industry;

3) unified distribution coal railroad capacity was [increased to] more than 169 million tons, some 9,279,000 tons more than that of the corresponding period in 1983;

4) coal reserves increased across the board, with the reserves for electric power, metallurgy, and railroads registering a great increase, and nationally, the use of coal by cities showed an increase of more than 2.7 million tons.

CSO: 4013/235

POWER NETWORK

PROJECTED 1984 POWER OUTPUT: 360 BILLION KILOWATT-HOURS

OW081046 Beijing XINHUA in English 0859 GMT 8 Aug 84

[Text] Beijing, 8 Aug (XINHUA)--China produced 214.19 billion kilowatt-hours (kWh) of electricity in the first 7 months of this year, an increase of 7.2 percent over the same period in 1983.

The country generated a total of 351.4 billion kWh of electricity in 1983, ranking sixth in the world; the generating capacity reached 76.44 million kilowatts, ranking eighth in the world.

Upon the founding of the People's Republic of China in 1949, China's generating capacity was 1.85 million kilowatts and the annual output of electricity was 4.3 billion kWh. China now generates the same amount in 5 days as it did in the entire year of 1949.

China expects to produce 360 billion kWh in 1984.

Over the past 35 years, China has completed or partially completed 65 large thermal power stations, each with a generating capacity of over 250,000 kilowatts, in coal-rich Shanxi and Hebei provinces and the Inner Mongolia Autonomous Region in north China, Henan Province in central China, and Shandong, Jiangsu, and Anhui provinces in east China.

China's hydroelectric power potential comes to 680 million kilowatts, of which 380 million are exploitable, ranking the first in the world. China has completed or partially completed over 80 large- and medium-sized hydroelectric power stations on the [Chang Jiang, Huang He, and Hongshui He] since 1949.

There are six transprovincial power grids, of which the Northeast, North China, Central China and East China grids are large ones each with a generating capacity of about 10 million kilowatts and with power transmission lines of 330,000 to 500,000 volts.

Construction has begun on the Guangdong nuclear power station--a joint venture with foreign interests--with a generating capacity of 1.8 million kilowatts, the first of its kind in China, and on the Qinshan nuclear power station in Zhejiang Province with its main equipment designed and developed in China.

By the end of 1983, China had over 86,000 small hydroelectric power stations in rural areas which generated 20 billion kWh of electricity last year.

Officials of the Ministry of Water Resources and Electric Power said that as China's power industry still fell behind the growing needs of economic construction and the life of the people, it would continuously be given priority in the development of the country's national economy.

CSO: 4010/125

POWER NETWORK

LIAONING BREAKS UP TRADITIONAL POWER STATION MONOPOLY

SK250459 Shenyang Liaoning Provincial Service in Mandarin 1030 GMT 24 Aug 84

[Excerpt] The Northeast Power Grid has done away with the traditional way of monopolizing the operation of power stations and has organized social forces to speed up the construction of power projects. At the Northeast Power Grid meeting to exchange experience in conserving power, utilizing power in a planned way, and relying on the masses in running power stations, which concluded today, a plan was formulated on collecting some 500 million yuan from the collectives to build two large thermal power plants, each with a generating capacity of 400,000 kW. The Shenyang branch of the China nonferrous metallurgical products corporation, the Daqing oilfield, and the Anshan Hongqi tractor plant are planning to collect 380 million yuan to operate power stations together.

Li Daigeng, vice minister of water resources and electric power, gave a speech concerning the above plans. He pointed out: It is not a temporary measure for the state to jointly operate power stations with local enterprises. It is one of the important economic policies of the state for a considerably long period of time. The power consumption targets should be set according to the proportion of investment. Enterprises that collect funds for operating power stations may enjoy power supply. Enterprises that collect a small sum should receive less power supply, and enterprises that collect a large sum should receive more. This is a good method for solving contradictions between supply and demand and is beneficial to the state, the localities and enterprises.

CSO: 4013/222

BRIEFS

HEILONGJIANG POWER INDUSTRY--Heilongjiang has increased its installed power generation capacity to 2.659 million kW, 66 percent more than in 1978 and its electricity output has increased by 60 percent over 1978. As of mid-July, it had produced 9.4 billion kWh of electricity, 47 times that of the annual power output for the early period after the founding of the PRC. The province now has five large modern power stations whose installed generation capacity is more than 200,000 kW each, three of them were completed after the 3d Plenary Session of the 11th CPC Central Committee. Over the past 6 years, the province has installed 19 high-voltage power transmission lines of more than 110 kilovolts, totaling 1,682 km, and newly added transformer capacity has reached 1.4 million kilovolt-amperes Today, 95.4 percent of the province's communes, 91.4 percent of its brigades, and 90.8 percent of its production teams have electricity. Power consumption per mu of farmland has increased from 7.5 kWh before the Third Plenary Session to 11 kWh. The province is building the Harbin No 3 Power Plant, the Shuangyashan pit-mouth power plant and the Jidong power plant, all large ones, to satisfy the needs of economic development. [Summary Harbin Heilongjiang Provincial Service in Mandarin 2200 GMT 26 Jul 84 SK]

ANHUI POWER PROJECT--General command for construction of China's first 500,000-volt direct current power transmission project was set up in Hefei 1 July with Vice Minister of Water Conservancy and Electric Power (Zhao Jingfu) appointed as head of the command. The total length of the power line is 1,080 km and the first stage of the project is to be completed in 1987. [Summary] [OW240105 Hefei ANHUI Provincial Service in Mandarin 1100 GMT 7 Jul 84]

NEI MONGGOL POWER PRODUCTION--In the first half of this year, Nei Monggol Region produced 2,001.43 million kWh of electricity, fulfilling the annual target by 51.32 percent, and 120 million kWh more than in the corresponding 1983 period. At the same time, the region saved 14,000 tons of standard coal and 9.25 million kWh of electricity for the state. In the January-May period, some 340 million kWh of electricity was used for developing agriculture, an increase of 10 percent over the corresponding 1983 period. [Summary] [Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 11 Jul 84 SK]

SHANXI-BEIJING LINE NOW OPERATIONAL--Beijing, 30 June (XINHUA)--The Datong-Fangshan 500,000-volt electric power transmission line, one of China's key construction projects, was formally put into operation today. The power transmission line starts from the No 2 electric power generating plant in Shanxi's Datong and ends in Beijing's Fangshan with a total length of 285.7 km. [Summary] [OW190617 Beijing XINHUA Domestic Service in Chinese 1740 GMT 30 Jun 84]

YUNNAN ELECTRICITY OUTPUT--The electricity output of Yunnan Provincial Bureau of Electric Power Industry in the first half of this year was over 2.66 billion kilowatt-hours, an increase of 22 percent over the same period last year. The bureau's profits in this period were some 54 million yuan, an increase of 55 percent over the same period last year. The taxes and profits submitted by the bureau to the state were over 43 million yuan, some 11 million yuan more than in the corresponding period last year. In the first half of this year, on average, raw coal consumed in generating a kilowatt-hour of electricity in the bureau was 2 grams less than the amount planned. The bureau saved a total of 2,900 tons of standard coal. [Summary] [HK030921 Kunming Yunnan Provincial Service in Mandarin 2300 GMT 26 Jul 84]

URUMQI ELECTRIC POWER GENERATION--Urumqi, 31 Aug (XINHUA)--The city of Urumqi in northwest China is now generating more than 1,100 million kilowatt-hours of electricity a year--110 times that of 1949, according to power authorities of the city. When the new China was founded in 1949, there were only three 800-kilowatt generators in the city, which is now an industrial center and the capital of the Xinjiang Uygur Autonomous Region. A 1,400-kilowatt power station was built on the Urumqi River in 1951, and a number of thermal plants have since been added. One of these, the Hongyanchi power station, is generating as much electricity in 5 hours as was generated in the whole region in 1949. In all, the autonomous region generated 2,800 million kilowatt-hours of electricity last year, compared with less than 1 million in 1949. [Text] [OW311118 Beijing XINHUA in English 0910 GMT 31 Aug 84]

ANHUI POWER INDUSTRY GROWTH--Anhui's power industry has developed rapidly in the past 35 years since the founding of the country. The total generating capacity of power stations throughout the province has reached 2,194,300 kilowatts, an increase of 153 times over that in the early years of the liberation. Last year, these power stations generated a total of 11.6 billion kilowatt-hours, equivalent to 479 times of that generated in 1949. In addition 75,800 kim of high-tension power transmission and distribution lines at or above 3,000 volts and 680 power substations at or above 35,000 kilovolts have been built. [Excerpt] [OW020807 Hefei Anhui Provincial Service in Mandarin 1100 GMT 31 Aug 84]

CSO: 4012/230

WAYS TO SHORTEN CONSTRUCTION TIME, REDUCE COSTS RECOMMENDED

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 3, 12 Mar 84 pp 4-5

[Article by Tan Jingyi [6223 7231 1138] of the Eighth Engineering Bureau of the Ministry of Water Resources and Electric Power]

[Summary] The instruction to shorten construction time and reduce engineering costs of hydropower stations from the central leadership is a major guideline for hydropower construction in China. The major problems in large hydropower projects are 1) inadequate early stage preparation and long construction time with their associated quality problems. The final part of the projects may drag on for a long time. Some projects cannot meet design specifications or inspection standards over an extended period and state investments cannot bring benefits into full play on time. The total construction time is usually over 10 years. 2) Unit prices and construction costs are rising daily. In addition to factors such as the increasing cost of materials, there is the technical level of construction. 3) Although the technical level of equipment is high--an average of 9,000 yuan per worker, over 10 percent of the total capital--the overall mechanization standard is not high, and equipment utilization rate is low. 4) Construction teams are too large (more than 10,000 people may be involved in a large hydropower construction project). The scale of temporary structures during construction is large, usually more than one-third of the main construction work. Housing and assistance costs can reach 8,000 yuan for each employee, more than 10 percent of the total investment.

There are many reasons for this situation. Aside from unreliable sources of funds and materials, inability to meet construction deadlines, substandard machinery, etc., major causes are lack of long-range planning, slow early stage survey and design work, and management's inability to respond to hydropower development needs. Technically, the emphasis is more on design than construction. And in construction, the emphasis is put on the main engineering projects while equipment is neglected. These have been long-standing problems and despite significant improvements in survey, design, research, and construction, in terms of overall construction time, costs, and engineering quality, things are even more backward than they were in the middle and late 1950's, especially in the aspect of economic benefits.

To meet the demand to develop hydropower with priority, the author believes that reforms should be carried out in the following areas:

(1) Ten- and 20-year electric power development plans should be formulated. Based on these plans, the early survey and design work to clearly identify the medium- and long-range construction projects in various areas can be conducted.

(2) Based on the need of hydropower development the present management should be reformed. A regional development organization can be established to manage survey, design, and construction.

(3) A special group of people chosen from experienced design and construction personnel should be organized to tackle major technological and economic problems in design and construction, to make policies, and to combine design with construction.

(4) Construction teams should be strengthened. Construction teams should be responsible for profitability, and divided into various professional jobs. Construction workers must be reduced to change the present clumsy structure and team quality must be improved, with the number of professionals increased from the current 3 percent to over 10 percent. Contract workers should be used primarily for excavation and concrete pouring. Rear bases must be built as areas for dependents and retired employees to live and as centers for training, research, medical care and repair, and processing. Last, the wage system should be reformed. These measures will reduce the number of workers on the construction sites by half. Labor productivity must be doubled and building and construction assistance costs correspondingly lowered.

(5) Early stage preparation work should be stressed. In this stage, a suitable construction plan is drawn up based on experimental studies initiated by combining the engineering aspects of the project. New techniques, equipment and materials should be adopted to create a good foundation for improving the technological and overall mechanization level of the construction work, shortening construction time and reducing costs. For large engineering projects being planned, the early stage work such as transportation, power for construction, communications, and living areas should be handled according to plan. The more the focus on hydropower construction is shifted to the southwest, the more this early stage preparatory work should be emphasized. An analysis of projects under construction, shows that investment in early stage preparation is approximately 5 percent of the total investment.

(6) Government investment in construction equipment should be discontinued. Construction equipment owned by hydropower construction organizations in China is valued at over 1 billion yuan. With the exception of a few large projects, new hydropower projects should not purchase equipment with government capital, using instead business depreciation funds and capital investment funds. Large equipment needed for a project may be leased by the government. These measures could lower engineering capital by more than 10 percent.

(7) A fixed price system should be implemented to gradually make a transition to contracting through bidding by businesses. Total investment and construction time have been fixed for large hydropower projects. Although this will help overcome overspending, the level of fixed unit price still lags behind and all costs are still relatively high. It is necessary to bring the fixed unit price to an advanced level. The amount and unit price of excavation and concrete in a large engineering project should be determined according to an advanced and rational construction arrangement and technological processes based on sufficient experimental studies. The larger the scale of engineering, the lower the unit price should become. The scale of temporary construction should match that of the main construction. The current temporary construction scale is large, one major reason being the low overall mechanization level. Investment in temporary structures should be held to within 30 percent of the main project. As the scope of the main project increases, this ratio should further decrease.

In summary, the potential to shorten construction time and reduce engineering costs is great. With government-assured investment, materials and equipment, total construction time for major hydropower projects could be shortened by 2-3 years (not including early stage preparation) and engineering investment could be reduced by 20-25 percent (not including permanent equipment and moving people).

12553
CSO: 4013/134

CHINA SOCIETY OF HYDROELECTRIC POWER ENGINEERING HOLDS FORUM ON HYDROPOWER DEVELOPMENT

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 4, 12 Apr 84 p 5

[Article by Zou Fanxiang [6760 5400 3276]: "China Society of Hydroelectric Power Engineering Holds Forum on 'Phase II' Work"]

[Text] On 25 January, the eve of the Chinese new year, the China Society of Hydroelectric Power Engineering held a forum to discuss the policy of the Party Central Committee giving hydroelectric power development the priority and the directive to choose the best proposals, reduce the construction cost and construction time. The forum invited 140 people, including managers in Beijing, persons in charge of special committees, experts in hydroelectric power technology, professors, and leaders of relevant departments to contribute ideas in hydropower development.

Minister Qian Zhenyin attended the forum and the society activity department of the Chinese Science and Technical Association sent representives to advise the forum.

The meeting was charied by Deputy Director Comrade Li Eding [2621 7725 7844]. Director of the Society, Professor Shi Jiayang [2457 0857 3568], gave introductory remarks and discussed the goals of the society for the next year, followed by an address entitled "Step Up Hydropower Construction" by General Manager Chen Gengyi [7115 6342 0308] of the Water Conservancy and Hydroelectric Power General Company. Senior specialists Comrade Wang Huzhen [3076 5170 2823] spoke on the need to open up the thought process, break away from tradition and create new prospects for China's hydropower construction. Committee member of the Chinese Academy of Sciences and Vice President of Qinghua University Professor Zhang Guangdou [1728 0342 2435] stressed the connection between building a work force and education. Director of the China Energy Research Association Lin Hanxiong [2651 3352 7160] introduced the 10 big issues in energy supply and demand. Comrade He Gegao [0149 2706 7559] of the Fuel and Power Bureau, State Planning Commission, made six recommendations for stepping up hydropower construction. Planning Bureau Director You Jishou [3266 0679 1108] of the Ministry of Water Resources and Electric Power expressed his views on ways to reduce construction costs. Deputy Director of the Water Conservancy and Hydroelectric Power Research Institute Comrade Shen Chonggang [3088 1504 0474] stressed the importance of scientific and technological

advances on stepped-up hydroelectric power development. Comrade Hu Haito [5170 3189 3447] of the Geomechanics Research Institute of the Ministry of Geology and Mineral Resources emphasized the geoengineering problems in site selection.

From begging to end, the atmosphere at the forum was spirited and participants actively engaged in discussion. Many good opinions were put forth from different viewpoints. The main points are as follows:

(1) The key to a reduced construction cost and a shortened construction time is the advance in science and technology. While making an effort to promote advanced science and technology achievements made in China, we should also actively import foreign technology for our use and to reduce the technology gap.

(2) The prerequisite of a good "phase II" is to do good preparation work. River planning and economic analyses should be done well, and advanced survey and testing methods should be used to improve quality and efficiency. In design, the thought process should be opened up and tradition should be transcended, new dam models should be studied and the optimum plans should be selected. Construction organization and design should be done well, preconstruction preparation should be simplied and new techniques, new material, new structures, and new methods should be tried.

(3) Important steps in the "phase II" work include strengthening business management, establishing a strong work force and improving enterprise quality. Specialty teams should be developped and base construction should be enhanced. Advanced equipment should be centrally assigned according to local conditions to improve the utilization rate.

(4) The technical policy should be strictly adhered to. A major effort should be made to compile technical regulations, codes, and the standardization of techniques. The relocation of residents from the reservoir flood control zone should be improved and regulations established. We should reach a stage when every step of hydropower construction has a legal basis.

(5) Actively cultivating and discovering talented people is a fundamental important to the development of hydroelectric power. Various effective measures should be taken to step up personnel training, make full use of existing science and technology personnnel and put the policy regarding intellectuals on a solid basis. The special disciplines and curriculum in colleges should be improved. The personnel structure regarding specialty and rank should be studied carefully so that the work force may be used most economically and rationally.

9698
CSO: 4013/162

DAHUA'S SINGLE GENERATOR ALREADY EASING DRY SEASON POWER SHORTAGE

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 5, 12 May 84 pp 10-11

[Article by Peng Wenzao [1756 2429 5679], Guangxi Bureau of Electric Power Industry: "The Role of Dahua in the Guangxi Power System"]

[Text] The first large-scale hydropower station on the Hongshui He, the Dahua hydropower station, officially started producing electric power on 1 December 1983 with its No 1 generator. The powerful current flows in a steady stream through a newly constructed 220,000-volt high-tension power line to Nanning and into the Guangxi power network. The capital construction of the Dahua hydropower station was accomplished by the broad ranks of hydropower workers and people in and outside the region who supported the Dahua construction. They achieved great results in 8 years of hard work and conscientious implementation of the State Council's instructions on speeding up development of the Hongshui He. The Hongshui He is a "goldmine" among China's water energy resources. After its completion, Dahua will not only play an important role in the future of the Guangxi electric power system, but also provide training and experience for the workers to use in future construction of Hongshui He cascade stations. This article will briefly discuss the above points.

The entire Guangxi area now has the Guangxi power network and the Wuzhou power network, with the former being the main system supplying power to Nanning and the cities of Guilin, Liuzhou, and Jinchengjiang. In 1983 the main system had an installed capacity of 1,272,900 kilowatts, and an output of 4.987 billion kilowatt-hours. The characteristics of this system are: (1) The system is predominantly hydropower; of the 1,272,900 kilowatt capacity, hydropower constitutes 742,300 kilowatts and an output of 3,256 billion kilowatt-hours, which makes up 58.3 percent and 65.3 percent of the system, respectively; (2) The power stations have a low flood peak, reservoir storage capacity is small, and there are shortcomings in its storage regulation. Except for Bihe (installed capacity 26,000 kW), which is adjusted yearly, Xijin, Luodong, Lalang, and Hemianshi are all seasonally adjusted; Mashi and Dahua are regulated daily and Etan is a run-of-the-river station. This system guarantees a large output-to-capacity ratio. As a result, there is a large disparity in output during the wet and dry seasons. For example, in 1982 the highest average monthly output of hydroelectricity reached 433,000 kilowatts with the lowest being 133,000 kilowatts. During the season

of abundant water, when the power system reached a peak load of 692,800 kilowatts, hydropower contributed 500,000 kilowatts and thermal power 192,800 kilowatts, even though thermal power requirements were 200,000 kilowatts. Since thermal power was subjected to minimal capacity restrictions and there was no reservoir regulation for hydropower, after midnight the system's output was greater than peak demand hours; water was discharged from the reservoirs which in 1982 alone was equal to 40 million kilowatt-hours of electricity.

Because the stations have low flood levels, during heavy flooding operations must be stopped for short periods, usually once or twice a year for periods of 5 to 7 days. During the dry season hydropower output is reduced and with a thermal power output of only 280,000 kilowatts, the system can only produce 410,000 kilowatts, leaving s short-fall of about 100,000 kilowatts. Since the 1970's there has been an annual short-fall of about 500 million kilowatt-hours during the dry season. Because of thermal power being short of coal and the poor quality of the coal, it is apt to cause the generating units not to operate normally and the power shortage to be even more pronounced. Under these conditions, the supply of electricity should first be cut off to manganese mines, chemical fertilizer plants, iron and steel mills, electrolytic aluminum and metal smelters and other big power consumers. At times, civilian consumers take turns having their power cut off, seriously affecting the industrial and agricultural production along with the lives of the people in Guangxi. After the No 1 generator of the Dahua power station went into operation, generating roughly 2.3 million kilowatt-hours of electricity a day, the dry season power shortage was considerably eased.

Originally, the Guangxi power system was set up to handle 220,000 volts. It is basically a radiating single loop, and when there is a change in the load, the voltage fluctuates a great deal and the quality of the power supply is not good. For the last 20 years, Nanning, the capital of the autonomous region, has been supplied with power through the Sijin single loop. But now electricity is supplied by two 220,000-volt lines, one from Dahua to Nanning and one from Dahua to Wutan, giving the main Guangxi power network a ringlike configuration of 220,000-volt lines between Dahua, Nanning, Xijin, Laibin, Heshan, and Etan and back to Dahua, thus bringing to an end Nanning's long history of a single loop and vastly increasing the system's reliability for electricity supply.

According to the Guangxi electric power plan, in 1984 the No 2 and No 3 generators of the Dahua power station, along with the No 7 generator of the expanded Heshan thermal power plant will go into operation. In 1985 Dahua's No 4 and Heshan's No 8 generators will go into operation. Once the volume is balanced on the basis of yearly peak load forecasts, the Guangxi power network will have a surplus of 456 million kWh in 1985 and a surplus of 556 million kWh in 1986. But because no new generators will go on stream in 1986, the dry season of 1987 will again bring a power short-fall of 50,000 kilowatts, but over the entire year there will still be a surplus of 356 million kWh. This shows that in the next several years Guangxi will have surplus electricity to send to Guangdong, reducing the amount of fuel used for thermal power there. At the present time construction has already

started on a 220,000-volt line from Heshan through Laibin and Wuzhou to Guangdong. This line will have a 220,000-volt substation built at Wuzhou to carry surplus electricity from the Wuzhou system to Guangdong.

In summary, the construction of the Dahua hydropower station will cause Guangxi in the next 3 to 4 years to go from an area of power shortages for many years to an area with surplus electricity. The Guangxi poiwer system will increase its electricity production in each of these years by more than 2 billion kWh, 50 percent more power than that produced by the present system. This will play a major role in the construction of the four modernizations in Guangxi. The construction of the Dahua hydropower station will also promote the unification of the Guangxi power network and push the development of the south China power system. It is the first step in the strategic measures to solve the energy problem in southern China.

12704
CSO: 4013/190

HYDROPOWER

SMALL-SCALE OPERATIONS ACCOUNT FOR ONE-THIRD OF GUANGXI'S POWER OUTPUT

HK090701 Nanning Guangxi Regional Service in Mandarin 1130 GMT 7 Aug 84 HK

[Summary] By the end of 1983, the installed capacity of all small hydroelectric power stations throughout Guangxi Region was 656,800 kilowatts, an increase of 6,080 times over the pre-liberation period. The installed capacity of the small hydroelectric power stations in the region now accounts for 32.58 percent of the installed capacity of hydroelectric power stations and thermal power stations. Before liberation, the region had only one hydroelectric station whose installed capacity was only 108 kilowatts. The region has now set up a small hydroelectric power administrative bureau and many prefectures and counties have also correspondingly set up small hydroelectric power companies or power industry companies. Electricity output of all small hydroelectric power stations throughout the region last year was 1,635 million kilowatt-hours, an increase of some 600 million kilowatt-hours over 1978. All counties in the region have set up small hydroelectric power stations, the installed capacity of each of 18 county hydroelectric power stations exceeds 10,000 kilowatts, and the installed capacity of each of three county hydroelectric power stations exceeds 20,000 kilowatts. In the region, 51 counties and cities mainly rely on small hydroelectric power stations for the supply of electricity used in industrial and agricultural production and in livelihood and 73.9 percent of production teams mainly rely on small hydroelectric power stations for electric supply.

CSO: 4013/204

BRIEFS

ZHEJIANG SMALL-SCALE OPERATIONS--In the first half of this year, Zhejiang's small-scale hydropower generated 727 million kilowatt-hours of electricity, fulfilling the year's plan by 51.9 percent. This year, although rainfall was less than in the comparable 1983 period in many places, the rate of usage of small-scale equipment was higher than for the corresponding 1983 period. [Text] [Hangzhou ZHEJIANG RIBAO in Chinese 1 Aug 84 p 2]

CSO: 4013/233

ECONOMIC ANALYSIS OF AUTOMATION OF IMPORTED GENERATORS

Beijing DIANLI JISHU [ELECTRIC POWER] in Chinese No 4, 5 Apr 84 pp 47-51

[Article by Xiao Shuhua [5135 2885 5478] of the Xi'an Thermoengineering Institute: "Benefit Analysis of Imported Generator Automation"]

[Text] Reviews of recently imported large-scale thermoelectric generating technological equipment generally say that their level of automation is high and there are many areas which we should study and learn from whether in automation system design, quality of software and hardware, or complete sets of equipment. Although ways of looking at the grade and model of generator automation levels are not all the same, there is unanimity in the view that emphasis in thermoelectric plant automation should be placed on ensuring safe and economical operation of the generators and on improving power plant labor productivity. The level of automation design and technological equipment of the large-scale thermoelectric generators imported by the Douhe, Dagang, Yuanbaoshan, and Baoshan power plants reflects the general situation in thermoelectric generator automation abroad in the early and mid-seventies. When reviewing the level of automation of the imported generators of these four plants, we will analyze and compare them on the basis of their role in electric power production and the actual benefits derived and use the experience absorbed therefrom as a reference for improving the automation level of Chinese-manufactured generators.

I. Generator Operation and Automation

Large increases in generator capacity demand corresponding improvements in the level of automation. In comparison with China's medium and small-scale generators, the automation of large-scale generators has obvious changes, primarily in the following areas:

1. Automation has become an indispensable mainstay for safe and economic operation of large generators.

As large generator systems are enormous and there is a strong interrelationship among operating parameters, they require many supervisory and control items. For this reason, generator operators on duty must rely on very good technological equipment and automatic systems made up of automatic monitoring, automatic regulation, automatic control, automatic protection, and automatic information management to be able to control effectively generator operation.

The boiler main fuel trip (MFT) automatic protection system, for example. Medium and small generator boilers do not have this device, but since there are many burners in a large generator boiler, the furnaces are large (some have two furnaces) and the need for strict controls on the fuel and air mix, ignition conditions and fuel situation, large-scale generator boilers should have a suitable MFT automatic protection system. According to statistics on accidents in China in thermoelectric plant operations, nearly 60 percent occur in the boiler. However, many incidents demonstrate that when the boiler has a good MFT system or a reliable furnace safety supervisory system (FSSS), there are greater guarantees of safe boiler operation.

Not long after the Dagang Power Plant's 1,025 ton/hour forced circulation barotropic oil-fired furnace went into operation there was a "blowout." A major cause of the accident was that the "high chamber pressure" trip protection had not been put into operation, so when the chamber pressure exceeded the set value (a 600 mm water column) the chamber lost its protection and finally caused an explosion in the chamber which extinguished the fire. In contrast to this, the Douhe Power Plant's 850 ton/hour natural circulation coal-fired boiler, the Yuanbaoshan Power Plant's 947 ton/hour low order forced circulation brown coal-fired boiler and the Baoshan Power Plant's 1,160 ton/hour forced circulation mixed coal and gas-fired boiler have also had the fire in the burner extinguished due to breakdown or improper operation, but because they had put MFT protection systems into operation there were no accidents. From this it can be seen that the safe and economic operation of large-scale generators is impossible if the support of good automatic technical equipment is lacking or abandoned.

2. There are essential changes in breadth and depth with the application of automation technology.

Large generators present very high demands for automated control. The automatic devices used should be highly reliable, highly precise, have high resolving power, high resistance to interference, and high-speed response. In addition, use for industrial applications also demands that they be flexible in installation, simple to repair, inexpensive and that they conform to the principles of standardization and general purpose use. It is clear that carrying on with the devices and methods used with medium and small generators cannot satisfy these demands, but that new methods and technology must be adopted.

Take burner and furnace flame monitoring, for example. On the basis of their goals and differences in fuel composition and fuel characteristics, the imported generators of the four plants use such scientific technology as closed circuit television, ultraviolet radiation, visible light, spectral frequency, thermal temperature, flame ionization, combustion airflow pressure differences, and infrared scanning. To improve the reliability of flame monitoring, they use a variety of monitoring techniques for the same object and also define these methods and control systems in logical language to achieve the goal of real time criterion of condition monitoring and process control with a high degree of reliability.

In other aspects, such new technological applications as using computers for roving monitoring, data processing, and accident recall and printouts (Yuanbaoshan and Dagang power plants), and for control of generator self-starting and stopping (Douhe and Baoshan power plants), application of accident recorders to analyze accident causes, application of switch recorders for operation status display, application of state interlocking conditions to form a large automatic safeguard and program control system, and application of thermal stress measuring equipment to control turbine acceleration and warmup time have brought about essential changes in the breadth and depth of large generator automation in comparison with medium and small generators.

3. Increased investment in automation.

The numerous large generator automation projects and technological innovations have increased investment in automation. It can be seen from the financial reports of imported generators of the four plants investments in generator automation makes up 4-5 percent of the total investment in generators and increased nearly 3-fold compared to the investment in automation for medium and small generators.

4. The level of operation management should improve correspondingly.

Advanced technological equipment also places new demands on the level of operational management. The incident at the Dagang Power Plant in which the fire in the fuel oil furnace was extinguished by an explosion summarizes experience in this area. It shows that advanced automation equipment should be controlled and operated by personnel of a corresponding level for it to have benefits. Investment in large generator automation should not only be in technology and equipment, but also in improving the level of operating personnel in power plant production management and generator operation. For this, many foreign power plant companies have established power plant operation simulation training centers to train qualified operations personnel.

II. Characteristics of Automation Systems Design and Equipment

The imported generators of the four plants have applied computer technology, control room technology, special automation systems for thermoelectric power plants (including analog or digital regulation, program control, signal warnings, and data processing) and information flow collating and data flow interfacing. Although there are differences among the four plants, the common features are to put safety and reliability first, and in addition to selecting reliable and practical hardware, also use software to reduce possible accidents in operation to the smallest range and lowest degree. For this they have adopted a series of measures, of which the important ones are:

1. Control, monitoring, and warning functions are separate as much as possible from components and functions and the protection system and other functions are completely separate. Adoption of this method makes the direct action protection system the final defensive method and also guarantees that when there is any trouble in control, monitoring, warning, or protection functions, it will not keep important information from the people on duty.

2. Design and layout of the boiler electromechanical single unit generator control room, computer room, control and interlocking logic cabinet workroom, input/output cabinet workroom, cable room, and instrument panel ensures overall coordination with the generators. This makes the specialized areas excellent work environments which is good for the operational life of the devices, reduces mutual influences, and improves the ability of duty personnel to respond to the generators.

3. An end level control level uses trouble security protection technology. Whenever there's trouble with the automatic control system and its power or air source, the end level control should maintain the original safe position, i.e., not influence the "off-line" manual control of the on-duty personnel and also prevent the end level from endangering the safety of personnel and equipment when control is lost.

4. In an automated system power supply network, redundancy or average load distribution method supplies direct and alternating current and uninterrupted direct current power source, thus improving the reliability of the power source and avoiding overall loss of function of the automated system due to trouble on a section of the alternating or direct current bus. This includes uninterrupted alternating current power source used in unusually important circuits including monitor computers, for certain important low power links (such as accident recording devices) use of an external emergency battery backup and inverse transformer power supply to improve reliability.

5. Trouble recovery written operational programs and search methods (such as function test boards and graphic instruments are provided for important automated equipment and systems (such as monitor computers and component type analog regulatory systems). System design can be for off-line or on-line protection using interchangeable solid state logic units and reserve components to facilitate rapid recovery of the equipment or system.

6. More components are installed in places in the automatic protection systems where reliability of search components can be influenced by operating conditions (such as the photosensitive components used for checking the flame in a boiler). Where two checking components are normally used, one is used for warnings and the other as a trip. The trip is activated by a logic circuit, but the two search components should not be connected in AND-gate form. In addition, there is a switch in the protection system to separating the search components during protection. This improves the reliability of the protection system and is extremely effective in preventing false moves or rejections in protection.

7. Numerous sensing elements are used to measure important changes (such as furnace pressure) in the automatic regulatory system. The sensing element uses "high zero order" wiring with high-low signal monitoring continuously monitoring the operation of the sensing elements. If there are major changes in values it sets off a warning signal. When a sensing element which is working is found to be "bad," it automatically switches to a "good" sensing element. In addition, the regulatory system is designed for trouble-free automatic/manual switching. Using these measures greatly improves the reliability of the regulatory system.

8. Multiple instruments are used for monitoring important parameters (such as monitoring qibao [3086 0545] or the water level in the steam and water separator) so that if by chance there should be a problem with the monitoring equipment its important functions can be provided (including providing instrument display on the BTG panel in the control room and sending information to the computer for tabulation printing, trouble warning or CRT display). In addition, multiple measurements also are integrated laterally with related regulatory system (such as combustion and heat load regulation). This coordinated and mutually supplementing equipment improves the on-duty personnel's sense of security and confidence in automation.

9. Selection of equipment and system design of the computer system is based on a use rate of 99 percent or higher. The regulatory system, control system and some of the protection system (such as protection against the furnace pressure getting too high and protecting against water getting in the turbines) of the generators, boilers, and auxiliary equipment all are designed for "on-line" maintenance and relevant components in the circuitry have test hubs so that test instruments can be plugged in for inspection and testing to inspect input and output signals without interfering with signal transmission. In addition, digital logic units and some transmitting devices (such as flame scanners) have output state monitor lights to provide on-line work status and rapid elimination of trouble any time.

10. Simplifying the control system as much as possible by using a great many control devices which are installed on the spot, are simple to use, and work directly. For example, in many auxiliary equipment systems, a great many pneumatic and hydraulic, electrical, and even mechanical base regulation devices are used; a great many pressure, temperature, flow, and physical position switches are used; a great many fixed sequence or conditional start-stop relay programmed controllers are used.

III. Examining the Level of Automation From the Perspective of Actual Benefits

Due to differences in technological equipment and design years there are differences in the level of automation at the imported generators of the four plants, including some things which urgently need to be improved. Although this is the case, we can learn something by comparing the actual benefits derived from them with similar generators manufactured in China.

1. Simplified operating measures reduced errors and improved safety of generation operation.

Operating experience has shown that in the process of starting and stopping generators and in changing the load, on-duty personnel often make mistakes due to being too tense. The automatic control system of the imported generators of the four plants uses a graded control structure--element coordination level, function group control level, drive control level. This both emphasizes dealing with logic control functions and causing the switch control system to make logical judgments automatically on the basis of the relevant criteria of the operational state to understand the operation state of the equipment at any time. In particular, the main devices with which this graded control is

equipped have the functions of automatic diagnosis, trouble display, automatic locking (automatic switching). For this reason, it not only simplified the operations tasks and measures of the on-duty personnel, but also to a great degree reduced the possibility of manual errors.

Take the start and stop control of the boiler's burners, for example. The coal-fired boiler of the Chinese-manufactured 300,000 kW unit generator has a direct current burner and uses light diesel oil as an initial ignition fuel: an electric arc igniter lights the light oil gun, then the light oil gun ignites the heavy oil gun, and finally the heavy oil gun ignites the coal powder. Due to the numerous (32) operations and complex (96) operational measures and also the lack of reliable burner monitor and control techniques, when the burner is started or stopped there is often poor judgment or a misoperation, thus the accident rate is high. By comparison, the effective automatic burner control system (ABS) and the automatic conbustion regulation (ACC) of the imported generators of the four plants basically has eliminated the possibility of operational accidents. The actual operation of the imported generators of the four plants demonstrates that automatic operation is safer and more reliable than manual operation.

2. Economizing on startup time reduced frequency of stoppages due to accidents and improved equipment use rate.

Generator start up time is an important mark of a power plant's level of automation. Important factors which have an impact on generator start up and stop speed are turbogenerator rotor and cylinder thermal stress, turbogenerator vibration and expansion, and its rotor temperature is an even more crucial question. For this reason, the imported generators of the four plants have added devices to monitor the temperature differences of metals in the turbine and control the turbogenerator start/stop speed and to measure the thermal stress of load change speed, and through a physical simulation of the temperature of a representative place (as at the 300,000 kW generator at Yuanbaoshan where they use a temperature probe entering the turbogenerator regulation level room to simulate rotor temperature) or by using actual measurements of generator steam parameters to calculate on a computer a digital analog of the thermal stress of the rotors (as in the 250,000 kW generator at Douhe and the 350,000 kW generator at Baoshan) to provide the turbogenerator's acceleration rate, generator warmup time, and load carrying speed in conditions of cold state, warm state, hot state and super hot state conditions. This provided a foundation for implementing an automatic start/stop of turbogenerators and also improved the generator use rate and the ability to respond to power network load shifts. One important reason why the operating heat consumption of generators manufactured in China is higher than the design value is that the generator start/stop process is long and idle consumption is high. From the perspective of the economic benefits of automation of turbogenerator starting and stopping alone it can be seen that the imported generators of the four plants annually can generate about 1 percent more electricity than similar generators of Chinese manufacture.

In addition, improved automatic systems improved the safety and reliability of generator operation and reduced frequency of generator stoppage due to accidents and thus improved the use rate of the equipment.

3. Implementing optimum control ensured quality of regulation and lowered consumption of fuel and plant electricity use.

Power plants abroad which have levels of automation and facilities similar to the imported generators of the four plants with oil-fired boilers produce electricity at a consumption ratio of 310 grams per kWh, and for coal fired boilers it is about 340 grams per kWh; their plant electricity use rate is 4-6 percent. The power supply coal consumption rate and plant electricity use of the imported generators of the four plants are basically in line with the above indicators. The following methods are used in automatic regulatory system to improve generator operation economy:

1) The unit generator coordinated control system (CCS) or the direct energy balance (DEB) control methods are used to fully utilize the stored thermal energy of the generators and improve the generator's load adaptation ability and tracking speed effectively controlling the generator load perturbation volume;

2) Regulation of the whole course of water supply is used which both satisfies the generator slip parameter startup and maximizes the economic benefits of adjustable speed water pumps;

3) A variety of types of superhot steam and reheated steam temperature regulation (flue recycling to add first order or second order spout) are used to guarantee that steam temperature will not change within the load range of 70-100 percent;

4) Electrical/hydraulic or pneumatic servo systems are used based on load and furnace pressure to automatically regulate axial flow forced draft and feeder blower blade angle (as at Yuanbaoshan) or centrifugal blower intake guides (as at Douhe, Baoshan, and Dagang) to control boiler air volume and exhaust and ensure the safe air pressure in the boiler and maintain optimum residual air coefficient;

5) Zero or low pressure loss methods are used to measure volume of flow avoiding loss to flow pressure created by flow volume regulatory devices, as in Douhe and Baoshan power plants where the imported generators use turbo-generator speed grade pressure to provide the steam flow volume analog signal for regulation;

6) On the basis of fuel need instructions and actual coal type correction feeder signal, through regulating the speed of the coal supply conveyor the volume of coal introduced is controlled and thus achieving the optimum mix of volume of fuel and volume of steam generated by the boiler;

7) Prefeed control and improved prefeed compensation accuracy is used to improve the generator tracking load ability and reduce dynamic errors in the parameters regulated improving the quality of regulation;

8) Control of speed of generator load increase and decrease is used in both satisfying the demands of large volume high parameter generator thermal stress

and also controlling generator load perturbation to suit boiler tracking load ability and improving generator response characteristics;

9) When there is trouble with auxiliary generators, the load to the boiler can be reduced to a suitable level to ensure the safe and economic operation of the generators.

4. It saves labor power, reduces labor intensity, and improves labor productivity.

Power plants abroad with level of automation and equipment situations similar to the four plants with the imported generators annual average 0.2-0.5 persons per kilowatt. The average number of persons per kilowatt at the four plants with the imported generators is much greater, but the number of on-duty personnel in the control room for starting and stopping the generators, operational adjustments, and emergency and accident work is clearly lower than similar types of Chinese-manufactured generators. This is especially so because reliable interlock protection and excellent automated control system not only does not require allocation of personnel for pumping, water, and cleaning, etc. greatly reducing labor intensity and [the need for] roving inspectors, thus improving productivity.

IV. Reflections and Ideas

We should work harder in three areas to use automation of Chinese-manufactured generators more extensively in ensuring the safe and economic operation of the generators and improving labor productivity. First of all, in a general sense, from primary and auxiliary generator manufacture to system design, automated equipment and boilers, generators, electricity and auxiliary generator systems should be treated as an operating entity. In the generators themselves, conditions should be provided for implementing automation and equipment controllability should be good. Secondly, combining with the actual situation at the power plant, automated control equipment and system selection should be based on the anticipated results and the maturity of their industry's applications with regard to the automated control method involved and the level of equipment and system. In terms of function, proceeding from actuality, we should choose simple, practical, and reliable methods to reach the goal of achieving similar results. Experience in operating the imported generators at the four plants shows that in some control and safeguard systems, using basic regulators, electromagnetic relays, and direct action type heavy current switches, simplifies the system and saves on investment as well as securing rather satisfactory operating results.

There is great potential for automation of China's thermoelectric power plant generators. The following points are presented for consideration:

1. In designing single unit generator functions, if the existing precision of the measurement of generator power, volume of water flow, volume of fuel flow, steam temperature at the primary steam gate, steam temperature at the reheater valve, high pressure heater outlet supplied water temperature could be raised

one level, then the difference between desired efficiency and actual efficiency of generators could be reduced by one-half. In this way, it would be possible to reduce the difference in actual efficiency of existing generators from 1.5 percent to 1 percent or less. Improving the generator efficiency of one 300,000 kW coal-fired generator by 0.5 percent could save 3,500 tons of standard coal per year.

2. Using zero loss or low pressure loss methods to measure steam flow volume, water supply flow and boiler blower volume to reduce the pressure loss caused by equipment that restricts flow. For a 300,000 kW generator, eliminating a pressure loss of 0.5 kg/cm^3 in the main steam flow caused by devices that restrict flow can lower generator heat consumption by 1 kilocalorie/degree and can save 300 tons of standard coal per year.

3. Installing automatic regulation of boiler combustion, maintaining optimum air-fuel ratio to strictly control excess air volume to reduce heat loss through exhaust. In tests with a domestic 100,000 kW generator, automatic regulation of combustion improved boiler efficiency 0.76 percent.

4. Using radial sealed automatic regulation of recycling air preheater to reduce leakage in the preheater. On the basis of the experience at the Yuanbaoshan and Baoshan power plants, using this regulation system on a 300,000 kW generator, air leakage rate could be dropped from 12-15 percent to 6-8 percent, saving 200,000-300,000 yuan in operating expenses per year.

5. If high capacity generators can have good protection systems, it is possible that the rate of forced generator stoppages due to operation control accidents could be reduced to nearly zero.

V. Conclusion

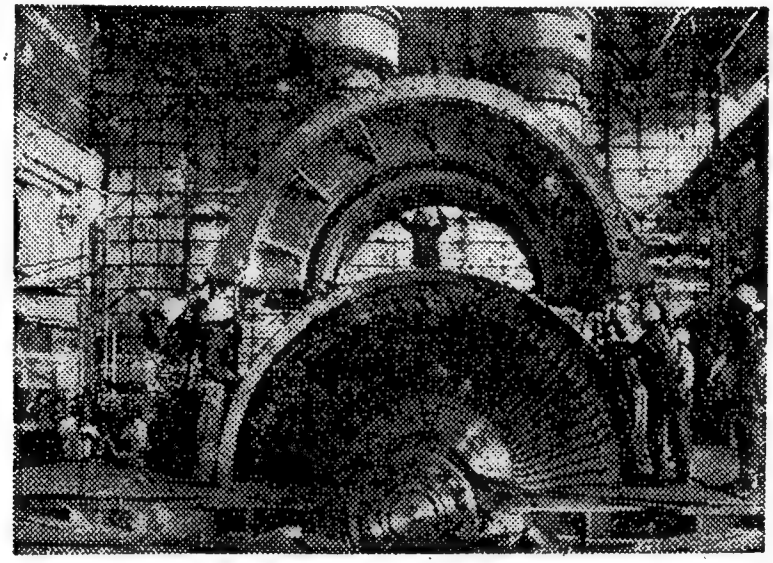
The level of automation of generator operation is a reflection of the overall technical level of a power plant. It is based on controllable conditions of primary and auxiliary generators and quality of equipment, system design, construction, testing, operations, and level of maintenance and management. Operating experience of the imported generators of the four plants shows that if any link in this foundation is poor, it can have an impact on the actual benefits of generator automation.

8226
CSO: 4013/170

THERMAL POWER

CONSTRUCTION SPEEDED UP ON YUANBAOSHAN POWER PLANT

Taiyuan SHANXI RIBAO in Chinese 21 Jul 84 p 4



[Text] Work on installing China's largest single unit turbine generator (capacity: 600,000 kilowatts) at the Yuanbaoshan power plant in Nei Mongol is being accelerated. The photograph above shows workmen lowering the turbine housing into place.

CSO: 4013/218

PLAN FOR SHANXI, SHAANXI HAS SMALL MINES SUPPLYING BIG POWER PLANTS

Beijing ZHONGGUO MEITAN BAO in Chinese 11 Aug 84 p 1

[Article: "Plans To Build Three Power Plants Now in the Preparatory Stage; Ministry of Coal Industry Study Group Says It Is Entirely Possible for Small Mines To Support Big Power Plants in Five-County Region of Northern Shanxi, Shaanxi"]

[Excerpts] In a five-county area of northern Shanxi and Shaanxi provinces that straddles the Huang He, it is entirely feasible to develop small coal mines that will supply large power plants, This is the view of a study group of the Ministry of Coal Industry following an inspection of the region. It has been decided to build three power plants, for which early-stage preparatory work is going on now.

The five counties whose small coal mine production is planned for the large power plants are Hequ, Baode, and Pianguan in Shanxi Province, and Fugu and Shenmu in Shaanxi. First, these five counties have a short frost-free period, the soil is poor, and agriculture is backward, supplying only some 70,000 yuan a year in revenue for the state. However, the region is very rich in coal resources with reserves estimated at 100 billion [sic] tons. The quality of the coal is excellent, with a thermal yield of about 7000 kilocalories. There are many coal seams at a shallow depth suitable for exploitation by medium and small mines. The five counties already have 193 small mines with a combined capacity of 1.2 million tons or so. Since transportation is a problem, these resources cannot be fully developed.

It has been decided to build one thermal power plant for Baode and Hequ with a yearly generating capacity of 3 million kilowatts--1.2 million kilowatts being the goal of the first phase of construction with completion scheduled for 1990. In Shenmu and Fugu each, a 200,000-400,000 kilowatt thermal power plant would be built. These five counties in Shanxi and Shaanxi are now carrying out early-stage preparation work with geological surveys in full swing. The study group has suggested that the three counties in Shanxi build a total of 18 county- and commune-run mines that would develop a capacity of 5.41 million tons a year by 1990. The two counties in Shaanxi would build 20 mines that could produce 3 million tons a year.

CSO: 4013/235

BRIEFS

HUANGJUEZHUANG UPDATE--With the all-out support of Yibin City and County, early-stage work on the Huangjuezhuang thermal power plant is progressing smoothly. The Yibin region is rich in coal resources, with reserves in the region representing some 60 percent of the entire province. However, most of it is smokeless coal, suitable only for generating electricity. Initial plans call for the mining district's nearby thermal power base to have an installed capacity of approximately 5 million kilowatts. With the close coordination of coal and electric power departments, both the mining of coal and the construction of power plants are moving forward together. Huangjuezhuang is the first power plant in the southern Sichuan (Yibin) thermal power base. It has a design installed capacity of 1.2 million kilowatts. The feasibility study report is due in August of this year and initial plans will be ready next year. It will be constructed during the Seventh Five-Year Plan as a logistics base for the economic development of Sichuan for the next 10 years. The power plant site has already been chosen and in order to accelerate the early phase construction, the Huangjuezhuang Power Plant Project Preparation Office was set up in January of this year. The project is being planned by the Southwest Electric Power Design Institute. [Excerpts] [Chengdu SICHUAN RIBAO in Chinese 17 May 84 p 1]

YONGAN EXPANSION PROJECT--Progress of construction of the third-stage expansion project of the Yongan Thermal Power Plant is satisfactory. On 23 May, the No. 5 generator began to power systems within the plant on a trial basis in order to establish reliability before entering the grid in July. Since April, the focal point of the project has been the installation of 175-square-meter electric dust remover. This involved the assembly of 314 cathode-anode plates on the ground and then the hoisting of each individual plate 40 meters into the air for reassembly in the housing. The comrades responsible for this work in the Provincial Electric Power Construction Company's Thermal Power Installation Office, under very adverse weather conditions, improved the hoisting and assembly techniques and completed the entire assembly in only 44 days, a month ahead of the original plan. [Text] [Fuzhou FUJIAN RIBAO in Chinese 1 Jun 84 p 1]

JIANGYOU THIRD STAGE--Preparatory work for the third stage expansion project (3 x 300,000 kilowatts) of the Jiangyou Power Plant, the largest thermal power plant in Western Sichuan, is in full swing. The feasibility studies are almost finished and the design plan tasks may be undertaken concurrently. With the demand for power growing daily in the western Sichuan region, hydropower alone cannot keep up and the electric power supply is strained during the low-water season. In order to resolve this problem, it was decided to further expand the Jiangyou Power Plant with three 300,000-kilowatt generators to regulate the peak loads. [Text] [Chengdu SICHUAN RIBAO in Chinese 25 Aug 84 p 2]

CSO: 4013/233

COAL INDUSTRY NOW TWO YEARS AHEAD OF OUTPUT TARGET

OW070818 Beijing XINHUA in English 0746 GMT 7 Aug 84

[Text] Beijing, 7 Aug (XINHUA)--China turned out 715 million tons of coal in 1983, ranking third in the world, next only to the Soviet Union and the United States.

The figure shows that the target set for 1985 in the state's Sixth Five-Year Plan (1981-85) has been fulfilled 2 years ahead of schedule.

Coal is China's major energy source, accounting for 70 percent of the total energy consumption in the country.

The output of coal came to more than 369.9 million tons in the first half of this year, an increase of 9.9 percent over the same 1983 period. The amount of coal cut in 15 days now is equivalent to the output in a pre-liberation year. China cut 32.4 million tons in 1949, the year new China was founded.

In the past 35 years, China has set up 1,834 key mines with a combined designed annual production capacity of 453.54 million tons. By the end of 1983, more than 40,000 locally run mines were built throughout the country with a total output of more than 350 million tons in the same year, accounting for half of the nation's total.

At present, 14 top-priority coal mines are under construction, with a combined designed production capacity of nearly 90 million tons. Beginning this year, these mines will go into production in succession.

By the end of 1983, China had verified coal reserves totalling 770 billion tons, of which 86 billion tons are recoverable right now. Of more than 2,000 counties throughout the country, 1,060 have known coal deposits.

More than 40 percent of China's coal extraction is mechanized, and 20 percent of the coal mines are fully mechanized with advanced equipment of international standard.

China plans to turn out 1.2 billion tons of coal by the end of this century to provide more "black gold" for its four modernizations program.

CSO: 4010/125

HUOLINHE'S SOUTH OPEN-PIT OPENED AMIDST MUCH FANFARE

OW011418 Beijing XINHUA Domestic Service in Chinese 1135 GMT 31 Aug 84

[Excerpt] Beijing, 31 Aug (XINHUA)--The General Offices of the CPC Central Committee and State Council sent a message of congratulations to the Huolinhe mining area construction headquarters and its party committee on 31 August, congratulating the completion and production of Huolinhe's south opencast mine, the first modern opencast mine in China.

The message says: You report to Comrade Yaobang saying that the south opencast mine will be completed and put into production on 1 September has been received. Comrade Yaobang has read your report and Comrade Ziyang has been informed of the report. They are very delighted and want us to extend warm congratulations to you from the Secretariat and the State Council.

The message says: The party Central Committee and the State Council attached a great importance to Huolinhe's south opencast mine in the course of its construction. Quite a few leading comrades inspected the construction site, setting strict demands on the work as well as giving enthusiastic support. The completion and production of the south opencast mine on time is a result of the hard work by leaders at various levels and workers and staff of the mining areas. It is also a result of the vigorous support from localities and departments concerned.

CSO: 4013/230

COAL

MODERN HUOLINHE OPEN-PIT MINE OFFICIALLY OPENED

OW010814 Beijing XINHUA in English 0642 GMT 1 Sep 84

[Text] Hohhot, 1 Sep (XINHUA)--A new mine at the Huolinhe opencast mining area in Inner Mongolia began production today.

Equipped with modern machinery mostly imported from the United States, Federal Germany, Japan, Britain, Finland, and Sweden, the Nanlutian mine produces 3 million tons of lignite a year.

This is the first opencast mine in the 540-square kilometer Huolinhe mining area on the Horqin grasslands in eastern Inner Mongolia and has easily-recoverable reserves of 12.9 billion tons. The area is expected to put out annually 50 million tons by the year 2000.

Preparations for the second stage construction of the mining area is underway. The completion of the mines will help ease energy shortages in eastern Inner Mongolia and northeast China. The first batch of coal is now being shipped to a power plant in neighboring Liaoning Province.

The Huolinhe opencast mining area is one of the five opencast mines undertaken in the Sixth Five-Year Plan period. The other four are Yiminhe, Yuanbaoshan and Jungar in Inner Mongolia and the Antaibao mine in the Pingsuo mining area in Shanxi. The development of opencast mines has been given priority in China's energetic drive to solve the energy problem.

The general offices of the Party Central Committee and of the State Council have sent a message of congratulations to the mine. The message praised the drives of the construction workers who completed the project in a short period of 3 years and encouraged them to continue their efforts to make the mining area one of the most advanced opencast mining areas in the world.

CSO: 4010/140

HUAIBEI, HUAINAN MAY PRODUCE 60 MILLION TONS A YEAR BY 2000

OW011154 Hefei Anhui Provincial Service in Mandarin 1100 GMT 27 Aug 84

[Excerpts] Over the past 35 years since the founding of the republic, Anhui's coal industry has developed rapidly with marked results. There are now over 900 local coal mines throughout the province. The Huainan and Huaibei Mining Bureaus have become two large coal production bases with an annual output of approximately 10 million tons. Last year Anhui produced 25.47 million tons of raw coal, or 240 percent of the total output of the 37 years before liberation. From 1949 to the end of 1983, Anhui produced a total of 465 million tons of coal and delivered 2.3 billion yuan in taxes and profits to the state, thus making important contributions to the development of the national economy.

The annual output of the Huaibei mining district has now reached more than 13 million tons and will estimably rank fourth in the nation. The Huainan mining district, though under difficult conditions in recent years, has still produced about 9 million tons of coal for the state each year.

Small coal mines south of the Chang Jiang are scattered along the river like men on a chess board. Last year their coal output reached 2.92 million tons, or 175 times that of 1949.

Since the 3d Plenary Session of the 11th CPC Central Committee, Anhui has further expanded the construction scale of its coal mines and continuously sped up the construction projects. At present, the construction of seven pairs of local coal mines and collieries whose products will be distributed under the unified state plan is in full swing. Their total capacity will be 21.1 million tons.

To suit the needs of the development of the national economy, the state has now decided to regard the development of the Huaibei and Huainan coal mines as key construction projects. According to plan, the projects will include the construction of 23 pairs of mines by the end of this century, with total capacity reaching 48.7 million tons, or 300 percent of the present capacity of these two districts. By 2000, their output will reach 60 million tons.

CSO: 4013/230

HENAN PRODUCTION APPROACHING 65 MILLION TONS A YEAR

HK080650 Zhengzhou Henan Provincial Service in Mandarin 1230 GMT 7 Aug 84

[Excerpts] Since the founding of the PRC, the province's raw coal output sharply increased from some 1.1 million tons in 1949 to some 64 million tons last year, a 57-fold rise that now ranks the province second in the country. The province's investment in the capital construction of coal mines has been 3.1 billion yuan.

Over the last 35 years, the Jiaozuo coal mine has produced 132 million tons of raw coal. Since the First 5-Year Plan, the province has been carrying out large-scale exploitation and construction in the Pingdingshan and Hebi coal mine areas. The Pingdingshan coal mine bureau had only one set of coal pits in 1957, and now it has 14. The bureau has produced 200 million tons of raw coal and delivered profits totaling 500 million yuan, ranking third in the country. The annual raw coal output of the Yima coal mine, the province's second largest coal mine, is 7.5 million tons.

In developing the coal industry, the province has implemented the principle of simultaneously developing large, medium, and small coal mines and of standing on its own two legs. Now some 70 counties and cities have coal resources, and local small coal mines are scattered throughout the province. Last year they produced 28 million tons of raw coal, 44.6 percent of the province's total coal output.

After 35 years of construction, the province has built five large coal production bases in the Pingdingshan, Jiaozuo, Hebi, Yima, and (Xinmi) areas and Zhengzhou, Luoyang, Xuchang, Anyang, and Xinxiang have become large coal producing cities. There are 140 state-run coal mines and 800 collective coal mines in the province.

Technology and equipment in the province's coal industry has been constantly improved, and 40 percent of the mining operation has been mechanized. The use of computers and industrial television has brought the province's coal industry to a new stage.

CSO: 4013/204

SHANXI MAY PRODUCE 400 MILLION TONS A YEAR BY 2000

OW151125 Beijing XINHUA in English 0720 GMT 15 Aug 84

[Text] Beijing, 15 August (XINHUA)--Shanxi Province, China's leading coal producer, will turn out 360 million to 400 million tons of coal a year by the turn of the century, according to Governor Wang Senhao.

This amount will account for about one-third of the national total, up from the present one-fifth. Shanxi produced 159 million tons of coal in 1983, according to a report in PEOPLE'S DAILY today.

Governor Wang said that the province plans to develop seven large mining and industrial areas, boosting production capacity by more than 300 million tons. They include the Gujiao mining area, which is projected to produce 16.5 million tons annually, and the Pingshuo mining area with an annual production capacity of 45 million tons.

Technical upgrading of existing mines will also contribute greatly to the increased output by then, he added.

Shanxi's known coal reserves are estimated at more than 200 billion tons, or one-third of the country's total.

Coal production is the province has increased steadily over the past 5 years, averaging an annual rise of 12 million tons, thanks to increased investment and other promotion measures by the government, including giving permission to collectives and individuals to open mines separately from the state-owned enterprises.

Apart from meeting domestic demand, part of the Shanxi coal is exported to Bangladesh, Japan, Britain and other European countries.

Coal provides about 70 percent of China's energy needs, and China is now the third-largest coal producer in the world following the Soviet Union and the United States.

CSO: 4010/133

SYMPOSIUM FOCUSES ON EXPERIENCE IN COAL FIELD HYDROGEOLOGY

Beijing MEITAN KEXUE JISHU [COAL SCIENCE AND TECHNOLOGY] in Chinese No 9, 25 Sep 83 pp 1-8

[Text] Excerpts of Academic Papers Presented at the National Symposium on Experience in Coal Field Hydrogeologic Operations

Editor's note: The National Symposium on Experience in Coal Field Hydrologic Operations, sponsored by the Department of Geology of the Ministry of Coal Industry, was held in Jiujiang, Jiangxi during May and June 1983. Academic papers presented at the symposium covered the following seven areas: open prospecting, exploration of massive karst water deposits, prospecting for water in arid regions, use of geophysical prospecting in hydrogeology, techniques in borehole construction, basic geological operations, and calculation of amounts of water. Workers in the fields of mine geology and hydrogeology should be able to draw upon the experiences presented in this article. This article should also help engineers and technicians in coal mine design, construction, and production gain a deeper insight into recent developments in applied coal field hydrogeology. Excerpts from some of the more representative reports are presented below.

Experience From Rock Hardness Exploration in Strip Mines[1]

Based on all the lessons we have learned from the past, we investigated the hardness of rocks and the regularities of rock hardness distribution in the newly opened southern portion of the Shaerhure strip mining area, in the Huolinhe coal region, so that we could provide reliable and essential data for determining the feasibility of using the bucket-wheel technique of coal extraction. By using various exploration and research methods, such as concentration samplings, various types of tests, interrelated analysis and composite interpretations, we compiled composite charts and documents, such as composite columnar section charts for bore-hole rock hardness interpretation, charts showing the relationships between rock hardness and their various physical characteristics, charts showing comparative rock strata and isolinear charts showing the percentage of pressure resistance of

various rocks above the principal coal seams. We also investigated rock depth, thickness and distribution throughout the strip mine rock system. The experience gained in exploring rock hardness was particularly significant in both strip mine exploration without requiring the use of the bucket-wheel method and in geological exploration for mining projects.

Hydrogeological Characteristics and Methods Used To Explore[2]

The hydrogeological conditions of the Yuanbaoshan strip mine, located on the Yingjin He River valley plain, is complex. As the Yingjin He passes through the center of the strip mine area and the Laoha He flows along the southern perimeter, and as there exists a powerful aquifer consisting of quaternary pebbles, gravel, and sand which cover the coal seam, the economic feasibility of developing this coal mine depends on the local hydrogeological conditions and accurate calculations of water discharge levels for future mines in this area. The soon-to-be-built Yuanbaoshan electric power plant also required that an accurate assessment of the overall usage for underground water be conducted.

Based on past lessons from the 1973 and subsequent 1975 explorations, we were able to begin the June 1980 hydrogeological exploration knowing the structure of the entire hydrogeological unit. Many methods were used including various systematically planned projects. For instance, tracing the origin and terminus of suspension of the Yingjing He. Five permiability experiments on the riverbeds of both rivers were conducted. Groundwater observation stations were set up at both the water intake and junction points. Five quaternary boreholes were drilled in the new mining area and dispersion tests and flow tests for well prospecting conducted. After completely surveying the water supply, we adopted cross-sectional methods to calculate the discharge for future mines, achieving rather good results.

After gaining new knowledge about the hydrogeological characteristics in this area by exploration and research, we were able to provide reliable data to design departments.

Weibei Coal Field Bedrock and Karst Water Exploration[3]

The base of the Weibei permo-carboniferous coal field is formed of lower paleozoic rock. In 1975, when coal mines in areas such as Hancheng, Chenghe, and Pubai were being built, there were numerous instances of phreatic discharge when galleries in the limestone seam hit +380 meters above the datum level. It became a matter of extreme importance to investigate the existing limestone karst water conditions in order to properly develop the 88.8 percent of coal resources below the +380 meter level. After 2 years of field surveys and laboratory studies, we arrived at the findings provided below:

1. The proven thickness of the entire ordovician limestone strata was found to be greater than 1,900 meters, as opposed to our previously calculated 400 to 500 meters. After carefully separating and identifying each stratum, not only were we able to pinpoint the main aquifers which were causing the recharging of various galleries, we were able to locate the impervious layers as well.

2. The structure and framework for water control became clearer after studying the regional base structure, its development and evolution during various periods. After the characteristics of Himalayan movement were pieced together and analyzed, it was felt that the karst water accumulation zone below +380 meters was primarily a rock stream fissure, completely void of air solute pockets, underground canals or karst ducts.

3. The extent of the effect of monocline pressure-bearing slopes was determined through analysis of data collected over long periods of time, where we observed water table dynamics in the main aquifers. We were able to divide bottom karst water into two dynamic systems, each system being capable of independent recharging and discharging. Understanding these two systems has helped us prevent, as well as use, karst water. We conducted hydrogeologic exploration and divided the Weibei Coal Field into four prospecting areas. To solve key problems and develop research methods, we found it necessary to identify and explore key targets in each prospecting area.

Exploration and Research of Guqiao Number One Coal Bed[4]

The Huainan No 1 coal seam constitutes 23 percent of the total coal reserves in the Huainan mining area. As the pressure head of the thin karst water layer in the Taiyuan series is tremendous, producing mines are greatly threatened by limestone bottom water should they strike this layer. In the Guqiao exploration area, there is only 16 to 20 meters of sand, mud and rock separating the first layer and the third and fourth Taiyuan limestone layers. Therefore investigation of the hydrogeological conditions of the No 1 coal bed has become a key issue in determining whether the first coal layer in this area is mineable.

In our hydrogeological exploration of this area, we combined comprehensive analysis with test drilling in sub-sectors. We combined findings from geologic boreholes with specialized geological boring, combined findings from long term observation boreholes with those from water pumping tests, combined single hole water pumping with multiple borehole pumping, combined steady pumping and non-steady pumping and observed the interaction among single-hole pumping sites. We found that these methods reduced costs and shortened exploration time. Detailed and thorough karst water surveys were accomplished in a little more than a year. After comprehensive studies, we concluded that the limestone supply to the third and fourth Taiyuan series was lacking, karst was poorly developed, hydrogeologic conditions were simple to moderately complex, and the amount of water discharge during mining the first coal seam was not all that great.

Application and Experiences Gained From Experiments on Pumping Massive Amounts of Water [5]

Fengfeng is a large water-bearing mining area. Although there have been nearly 100 exploratory ordovician limestone hydrogeological drillings during past water source exploration and coal mining operations, it was not possible to satisfactorily reveal the main characteristics of the ordovician karst water due to the low scale on which pumping experiments were conducted. The error of calculated water discharge and the proven amount has usually been great.

From 1976 to 1980, we began to exert control over ordovician karst water. Good results were achieved when we conducted three successive heavy flow pumping experiments in the Fengfeng mining region (amount of pumping was greater than 0.2 cubic meters per second).

1. We further investigated ordovician limestone, a complex aqueous structure in itself, and studied the corresponding relationships between the uneven development of karst and existing intensive runoff areas. We investigated the extent to which drying affects groups of springs during pumping operations. Later, we predicted the direction of main water flow of the mine's ordovician lime water.

2. Accurate hydrogeologic parameters were obtained. For instance, based on these parameters, the predicted amount of pit discharge of ordovician limewater for the Wangfeng mine at level +70 (rise/fall 15 meters) was 7 to 8 cubic meters per second. This value was not only very close to the actual amount but more than four times the calculated value based on individual small opening water pump input/output experiments.

3. Reliable data for assessing the accessible water reserves has been made available. For instance, in 1980 the city of Handan faced a serious water shortage, yet heavy water pumping experiments showed that the city's Erlishan water source area had accessible reserves of up to 1.65 to 1.83 cubic meters per second, capable of assuring ample water supply to Handan.

Heavy pumping experiments have also been used to investigate water conductivity (or blocking) and have been used to learn more about water supply "windows" in faults. The conditions seen during water dredging operations can now be simulated during massive pumping experiments, results have been satisfactory.

This type of pumping experiment has proven to be an effective means for specialized hydrogeological prospecting in northern China's mining areas which are known to be plagued with vast amounts of karst water.

A Means To Solve the Water Source Problem in Gujiao Mining Region[6]

The Gujiao mining region is one of China's principal bases of coking coal production. Construction has already started in the two mining areas of Xiqu and Zhenchengdi, however opinions are divided as to the degree of involvement of Taiyuan source water and efforts to protect Puci Springs. Consequently, a unanimously agreed plan for solving the water problem in the mine area has been slow, delaying construction work of the mine area.

Gujiao mine area and Taiyuan city share the same 5,700 km^2 hydrogeological unit. The Hanwu and ordovician system's limestone water permeates 2,790 km^2 of the supply area. It is estimated that karst water constitutes 79 percent of the natural supply of underground water. We discovered through further exploration and research that the depth of the paleolithic limestone erosion boundary and the hydraulic conditions of the active fractures, deep below the basin area, are the two principal controlling factors of the local karst hydrogeologic situation. Based on determined boundary conditions

and calculations of the local water table, we discovered that the source region which we were assessing, actually extended over 1,410 km^2 and was connected to the Taiyuan-Dongshan and the southern portion of the Zhoushan unit. The drainage area also involved an underwater evaporation zone in basin areas, which were primarily formed by the supply of underground lime-water. After initial assessments of the area's annual natural supply of phreatic water over a period of many years, it was found that 1 year's supply of water could run as high as 621 million tons. Moreover, the Taiyuan area is still supplied by an annual water runoff of 175 million tons. By using the method of drilling holes and irrigating water back into the karst aquifer, 70 million tons per year could be provided for use. The Fenhe reservoir provides 125 million tons of water to Taiyuan city, which produces an annual 200 million tons of industrial and human waste water. This water must be treated and purified for general use. The Taiyuan area could now have more than 1 billion tons of water, supplying the 849 million tons of water needed by various sectors.

Before this, the maximum amount of accessible underground water for the Taiyuan area was 365 million tons per year. There is still a surplus of 256 million tons of water between the mean annual amount of supplimentary underground water and the extracted water. This surplus water and the amount of mean surface evaporation of local underground water are in agreement with each other. We should view this system as a "static water storage," that is, the amount of water should not be altered, even though it remains a potential source of water. The present three problems of ground sinking, decrease in spring water, and encroachment of alkaline areas are all related to the improper tapping of underground water. From now on, we can only control and reduce the amount of underground water extracted from the porous shallow part of the basin. Direct tapping of karst water in the vicinity of Puci Springs must be avoided. Instead, we should tap the karst water trapped in the porous foothill flood-buffer sedimentary layers. It is also possible to directly tap the underground karst water in the Dongshan area, while at the same time, phreatic water could be dredged, thereby protecting Puci Springs and benefiting the large salt areas. In overall consideration of the potential tapping of Taiyuan groundwater, where proper balance and rational tapping of water resources would be maintained, we feel that the best means for solving the water problem in mining areas is to tap underground karst water.

Prospecting Methods in the Heidaigou Karst Area[7]

Jungar Coal Field is one of the five major strip mines presently being developed. It has always been felt that the planned mining area, which lies entirely west of the Huang He, is a crevice area lacking in karst water. The amount of discharge of boreholes has generally been less than 0.201/s.m, which is far below the proposed 0.5L/s.m level for initial stage plans for overall mining areas and the required 1L/s.m level for final stage mining areas. Therefore, it is imperative that prospecting for water in the western Huang He region be conducted.

Based on the characteristics of the Hanwu and ordovician limestone layers along the banks of the Huang He and the large exposed areas to the east, as well as the various vertical seam and strike dissected aquifers and runoff

from multiple spring complexes, we decided that our work should be based on surveys and water prospecting methods, where boreholes are drilled in an ascending order of distance. This method allowed us to conduct distant ground control over large areas. From looking at the hydrogeological unit as a whole, we were able to determine a systematic means for finding water. For instance, as a portion of the area's structure is sloped, there are only a few medium-sized ordovician springs southwest of the unit. There is, however, a complete and very thick aquifer below the water table whose underground water is potentially exploitable.

We used the "water storage structure" theory to analyze the triple aquifer complex along Yushu Wan; these aquifers have thicknesses of up to 500 meters below the water table. Of these aquifers, the middle ordovician serious aquifer has a thickness of 180 meters. There is also an impervious boundary. The northwest oriented Yushu Wan normal fault blocks the two sides of the limestone seam and its hydraulic connection. The northeast tip has an ordovician beam impervious fault and impervious flexure. There is a runoff area as well as a supply source. The supply conditions are better than the runoff conditions, which accounts for the formation of the Yushu Wan impervious water storage structure. After drilling as expected, all along Yushu Wan, there was a very powerful aquifer, and only the middle ordovician series aquifer drill holes had a discharge rate of 34.3L/s.m, which qualifies it as a primary source aquifer. The results of our preliminary steps in this area have advanced efforts in establishing a basis for prospecting for water sources.

Use of Simple Hydrogeologic Observation to Study Karst Regularities[8]

The Geding exploration area is located along the northern rim of Quren coal field, Guangdong. Its coal seam is the Longtan coal seam system. The eastern portion is covered by a cretaceous system of calcirudyte with karst development in the conglomerate rock and is classed as a blanket-type karst area. During our final detailed survey, we stepped up our basic hydrological and geological observation operations, in order to study the regularities of local karst growth and to obtain better results. The method we used was: (1) Systematic Logging of drilling and various karst phenomena in the rock core and logging interpretations. Statistics of the levels of the karst rate for each hole was taken and based on these statistics, an isolinear map of karst rate and a chart showing the curve of change of vertical karst rate was compiled. These were used to study the regularity of karst space distribution. (2) Basic hydrology, rock core records and well logging curves of various boreholes were comprehensively studied, and the strength of the karst belt and other aquifers and impervious layers of single holes were separated. After comparisons were made, a karst ratio chart was compiled, dividing the areas of strong and weak karst belts. (3) A chart showing the thicknesses of weak karst belts was complied to study its relative water blocking functions and a chart showing the altitudes of the conglomerate base was also compiled.

Moreover, various information on the existence of coal seams were compiled to serve as a basis for the planning department to determine water damage prevention and water inundation and retention damage prevention of coal columns.

Having performed these operations, not only did we learn about the hydrogeological conditions for the prospecting area, but also discovered a key means for studying karst distribution regularity.

Samplings From Quaternary Strata[9]

The Yuanbaoshan strip mine area is a quaternary system composed primarily of loosely packed smooth gravel interspersed with sand and pebbles of different sizes. The rock core is very difficult to extract and the rate of extraction is roughly 30 percent. As the quaternary structure greatly affects the calculation of the amount of water in strip mining as well as the stability of mine walls, our exploration required that the entire core of the quaternary stratum be removed. We used the two methods, namely slash weight extraction and shaft impacting. The mean rate of extraction of quaternary stratum for 75 boreholes was 86 percent. The rate for class A and B holes was 98 percent which conformed to quality standards. The methods used are described below.

The slash weight extraction method utilizes a drilling rig to raise and drop a slash weight onto a hoop placed over the lower end of the rock core, digging deeper while the rock core is extracted. This method is suitable for boreholes with depths of less than 20 meters. The shaft impacting method uses the drill's own weight for drilling. The pipe for removing the core, located in the impacting borehole, advances downward and removes the rock core. If raising the drill should meet with resistance, the drill tool can be hooked up to the vertical shaft and then rotated, or it can pound in a upwards motion. Both of these methods must make best use of impacting time. Hard drilling should be avoided in order to prevent accidents in the borehole. Each time after removing rock core, the sand and powder would be removed and borehole walls should be checked for needed repairs. In order to maintain the drill tool's vertical movement and to maximize its pounding power, the borehole must have a ϕ68mm drill stem running the entire length of the drill tool. The lower end of the short pipe, used to extract the rock core, should be properly annealed in order to prevent cleavage during pounding.

Explanation and Application of Well Logging in Quaternary Structures[10]

Quaternary strata is a loose structure with a high degree of porosity. Its aqueous capacity is good, the amount of radioactive elements is low and there is marked physical difference between quaternary structures and bedrock. Therefore, the curves of various well logging parameters, likewise, have distinct characteristics. For example, apparent resistivity is markedly low and natural gamma amplitude is lowered by a whole order of magnitude. These parameters may be used to serve as a basis for accurately deciding the contact face between the quaternary strata and bed rock. The various strata can be interpreted by means of comprehensive analysis of the characteristics of various curves associated with well logging. Generally speaking, the existence of a sand layer is determined when there exists a large anamoly between the rate of apparent resistivity and natural potential, or when the gamma curve and density values are low. The granularity of the sand layer can be determined based on the relative values of the anamolies.

The existence of a clay layer is determined when the difference between the anamoly of the natural gamma curve and density curve is great, or when the apparent resistivity and natural potential are low. Sand content can be determined based on the relative values of the various anamolies. Based on the data derived from in-depth research on the area, a composite and standard columnar section chart for test wells in the chart for test wells in the quaternary system could be made. Comparisons with neighboring boreholes is yet another possibility so that the regularities of change of each strata in the exploration area might be better understood. By using the basic data provided, further steps might also be taken for compiling quaternary strata isopoch maps, petrographic transformation maps, and statigraphic correlation maps.

The Use of Interrelated Analysis in Interpreting Well Logging Data of Porous Rock Strata[11]

Dongrong coal field is a rigid fissure deposit covered by an immensely thick layer of porous rock. The investigation into the range of distribution and regularities of change in the strata boundaries, lithological characteristics, depth, thickness, aquifer and impervious layers were all very important tasks in our hydrogeological work.

Based on the older method of interpreting interrelated well logging curves, we summarized all the unique physical characteristics of local quaternary strata and based on the large amount of geological data from boreholes and the relationships among the potential curves and ratios, we studied the relationship between apparent resistivity and depth. We then arrived at regression equations for the variables, and used the curves provided by the equations to arrive at a new method for interpreting well logging curves--the ratio plotting method.

We used this method in over 100 borehole experiments in the Dongrong region for interpreting well logging data. After comparing ten boreholes, we discovered that the error of well logging data for both cored and uncored boreholes declined as the rate of drilled rock core extraction increased, showing how the ratio plotting method was actually quite successful.

The ratio plotting method is easy to use, and interpretation of curves is standard. This method can be easily mastered and not only is the accuracy of interpretation increased from four to five times, but human error in interpretation is also reduced. Therefore, overall accuracy of interpretation is increased.

Discussion on Flushing Fluids and Flushing Methods[12]

The percolation coefficient of aquifers is normally obtained by using data from water pumping experiments. In dealing with unique situations where clear water was difficult for our unit to obtain during drilling operations in the Ronghua mine pumping experiment, our team established a group of pump test holes in an evenly developed, uniformly thick and geologically similar quaternary pressure bearing aquifer. The group of boreholes were comprised

of four main pumping holes and 13 observation holes. Three types of flushing fluids were used to wash the finished wells, namely: clear water, ordinary think slurry, and calcified slurry. Three types of flushing methods were used: the air compressor method, combination air compressor-piston action, and the combination chemical reagent-air compressor methods. Our comparison of findings from the experiments showed that when the same flushing method was used, the stability of clacified slurry was good. It proved to be stable and had a strong resistance to erosion. Water loss was minimal and rapid formation of strong and resilient smooth false walls was possible, reducing the amount of horizontal penetration of flushing fluids into rock crevices. The chemical method was easy to use in treating the well; the amount of water discharge for this well was the closest to normal and the calculated percolation coefficient and laboratory results were also in close agreement. Use of chemical reagents to clean wells was fast and even. The original structure of the aquifer was not damaged by fracturing. The best results were obtained when using chemical reagents in combination with air compressors to clean the well. Results were also good when our team used the above mentioned method in deep water pumping experiments.

Classification of Karst Water Exploration in Shandong Coal Mines[13]

With many years of practical experience in coal field exploration, we began our analysis and study of the hydrogeological conditions of coal mines by concentrating on the necessities of coal mine construction and production, paying particular attention to the amount of water discharge in mines, and whether or not this discharged water could be eliminated by drying.

The main aquifers in the Shandong coal field are carboniferious and ordovician system limestone aquifers. The many thin limestone strata in the carboniferous system are closely related to the coal seam; this is a key point in Shandong hydrological exploration operations.

Studies based on a large amount of research data have shown that the amount of water dischrage in Shandong mines is largely dependent on the abundance of water in the direct charging karst aquifer. (These aquifers may be divided into three types: "aquifers whose discharge is due to a broken cap." This type of aquifer is positioned above the coal seam and discharge moves downward as the cap is jolted during mining operations. The second is the "exposed underground aquifer." It borders on, or is located in, the vicinity of the coal seam. Charging occurs during mining operations. The third type of aquifer is the "bottom pervious aquifer" which is located below the coal seam. Discharge occurs when galleries bottom out.) The question of whether mine water can be eliminated by drying is determined not only by the existence and capacity of the water source, but also by the degree in which the supply channel is obstructed or unobstructed.

We established a standard of measurement, based on the discharge levels, for "directly charged karst aquifers." Units were classed as having "substantial" or "less than substantial" sources of water. In our exploration of underground karst water in Shandong coal mines, we established four categories and eight sub-categories for the various amounts of source water. This method of classification is systematic, specific and simple for use. A scientific means is now available for use in exploring Shandong coal field karst aquifers.

Further Work in Coal Mine Hydrogeology Work Must Be Implemented[14]

Yunzhuang mine in central Jiangxi is located on a small and independent hydrogeological unit outside the major coal field belts. Yunzhuang mine is an experimental coal mine which extends below the Changxing karst water structure. Exploration of this mine was announced in 1968. Mining operations began in 1980, and in 10 years, explorations, capital construction, drainage tests and trial production were conducted. Yunzhang mine has also experienced many types of hydrogeological phenomena, such as the complete disappearance of karst water, sudden inundations, surface seepage and collapse. As hydrogeological work has never ceased, volumes of complete hydrogeological records exist for this area. After certifying and testing hydrogeological conditions of mine shaft operations five times, a model of the mining area was initially built so that hydrological forecasts could be made. It was later realized that hydrogeological mining operations would not be completed so easily. This was particularly true with the highly complex hydrogeological conditions of the mine shafts. The only correct thing to do was to have the capital construction department continue its hydrogeological operations during its construction operations. The capital construction department would have to ensure smooth construction and safe working conditions while at the same time update and supply new findings in geological reports all the while continuing its hydrological forecasts. Even after the mine goes into full production, production departments should continue to conduct their work, based on the hydrogeological findings as provided by the capital construction department. Until no longer needed, hydrological forecasts should take into account the results of actual data obtained during each phase and at each level; findings should be constantly updated.

FOOTNOTES

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CSO: 4013/65

BRIEFS

YIMINHE WORK INTENSIFIED--Hohhot, 20 August (XINHUA)--An all-out effort is being made to get the No 1 opencast mine at the Yiminhe mining area in northeast [Nei Mongol], ready to produce coal by 1 October. Up to now, more than 600,000 cubic meters of earth and stone have been cleared at the mine, which is designed to produce 1 million tons of coal a year in the first phase, beginning next year. The Yiminhe coal field has coal reserves of more than 12 billion tons. Roads, railways, and communications facilities have been built in the area and schools, hospitals, shops and residential quarters erected. The Yiminhe mine is one of the four large opencut coal mines being built in [Nei Mongol], which boasts known coal reserves of 194 billion tons, next only to Shanxi, China's leading coal producer. [Text] [OW201501 Beijing XINHUA in English 1039 GMT 20 Aug 84]

CSO: 4010/133

OIL MINISTRY DESIRES DOUBLING OF ONSHORE RESERVES IN SEVEN YEARS

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese
Vol 5 No 2, Jun 84 p 131

[Report by Gao Xinqing [7559 2450 1987] of RENMIN RIBAO and Ding Shi [0002 1102] of JINGJI RIBAO: "Ministry of Petroleum Industry To Strengthen Oil Exploration, Strive for Doubling of Proven Onshore Oil Reserves Within Seven Years"]

[Text] The Ministry of Petroleum Industry has decided to greatly strengthen oil exploration work, and in the period from the present to 1990, to double the nation's total proven onshore reserves of petroleum, and to expand to an even greater scale with the inclusion of the offshore by the end of the present century. Taking 1984's crude oil production of 110 million tons as a yardstick, the average annual increase will have to exceed 5 percent. China's petroleum industry has already entered into a new age of development with a steady increase in both speed and efficiency.

Within the Ministry of Petroleum Industry, from the leading Party group at the ministry to the individual oil field, stress has been placed recently on the important point of "how to arrange a central strategic plan, to speed up development, and to increase reserve strength?" A synthesis of everyone's practical experience in the development of the petroleum industry revealed that the attitudes appearing over the last few years, such as "oil reserves and production are difficult to increase," do not tally with reality, and that reserves are a prerequisite for the development of the petroleum industry; only if there is a great increase in reserves will the increased production of crude oil be sustained, and only then will there be reserve strength for development. Since 1981 the ministry has taken the income from the price differential of over-production of target quotas and collected several billion yuan in exploration development capital and has also transferred personnel and materiel, strengthened exploration work, and got a foothold on reserve quantities. At the same time, they broadened the use of state-of-the-art exploration techniques, clarified many complex geological circumstances that had been elusive in the past, greatly increased the recognition of geological structures and of the rules of oil pools, and very greatly expanded the territory of oil exploration. This had an important effect on the efficiency of oil exploration. From 1981 to 1983 the nation's newly discovered oil reserves were 1,060,000,000

tons; several dozen structural zones containing oil and gas were found. From these, 570 million tons of geologic reserves were discovered last year. It was the third best year ever, third after the discoveries of the Daqing oil field and the Renqiu oil field. Most recently, the leading Party groups of the ministry have emphasized that at every level of Party and administration the number-one man must personally take charge of exploration and reserves, with exploration work in first place. In exploration work they must work toward the "five optimizations": capital, seismic work, test well drilling, providing equipment, and making technical guarantees. At the same time they proposed the rectification and reform of the enterprise, cadre training, the increase of political ideology, and other measures.

Presently, the Ministry of Petroleum Industry is continuing to increase exploration work around the edges of and in the deeper areas of old oil areas, while energetically developing exploration in the great northwest and in coastal waters. At the same time, they are paying attention to the import of state of the art foreign technology and crucial equipment to broaden several productive lines of exploration experience. From now on they will constantly be making breakthroughs in new regions, in new strata, at new depths, and bring in new high production oil and gas wells one after the other. This excellent situation presages a new golden era in oil exploration about to dawn in China.

12663
CSO: 4013/198

MATHEMATICAL GEOLOGY PLAYING A LARGER ROLE IN PETROLEUM PROSPECTING

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 4, No 2, Jun 83 p 159

[Article by Yang Wenkuan [2799 2429 1401] and Chen Zien [7115 1311 1869]: "Mathematical Geology Will Make More Contribution to Petroleum Geology"]

[Excerpt] The first "National Applied Sciences Symposium on Mathematical Geology in Petroleum Resources Forecasting and Geological Exploration" sponsored by the Petroleum Society of China, the Petroleum Geology Society of China, and the Mathematical Geology Committee of the Geological Society of China was held in Leshan, Sichuan on 10-16 April 1983. One hundred fifty-seven authors and invited delegates from 76 organizations including the Ministry of Geology and Minerals, the Ministry of Coal Industry, the Ministry of Nuclear Industry, the Ministry of Metallurgical Industry, the Chinese Academy of Sciences, the National Seismology Bureau, higher learning institutions, the People's Liberation Army, petroleum science and technology periodicals, and GUANGMING RIBAO, attended the meeting, the majority being young and middle-aged technical personnel.

The 117 papers exchanged at the meeting demonstrated that the use of mathematical geology in petroleum geology was fruitful and effective in spite of its late start and numerous difficulties. The authors used mathematical tools such as probability and mathematical statistics, fuzzy mathematics, differential equations, operational research, finite element method and frequency spectrum analysis and digital leaky wave to provide better answers to geological questions such as quantitative projections of oil and gas reserves in geological surveys, mathematical modeling of the evaluation of organic materials, mathematical modeling of sedimentation, mathematical modeling of crustal stress fields, mathematical modeling of geothermal fields, stratigraphic classification and correlation, geological interpretation of physical exploration and test well data, trap evaluation, and identification of casein and other organics. A lot of work has also been done in the design and establishment of a petroleum geological data bank. The meeting reflected the current research level. Some papers were unique in theory or in technique and may fill some voids.

There are differences in the understanding of the term "mathematical geology." It seems that mathematical geology mainly consists of three aspects: the study

of the statistical pattern of a geological quantity; the mathematical modeling of a geological process; and the theory and practice of a geological data bank. In addition, the policy-making in survey and exploitation as well as some mathematical problems in exploitation should be included in the domain of mathematical geology. All these areas have a great growth potential. One may be sure that the accurate use of mathematical geology in petroleum prospecting on a wide scale can definitely reduce the blindness in survey and exploitation significantly, and yield huge economic benefits.

We should provide relevant technical personnel with the necessary working conditions. Many urgent technical problems to be solved in petroleum prospecting not only involve many branches of geology and mathematics but also involve disciplines such as organic geochemistry, chemical kinetics, chemical thermodynamics, fluid mechanics, heat transfer, solid mechanics, and even astronomy. In order to solve these problems, we must allow the relevant technical personnel to collaborate through various means and technical information and working experience must be exchanged.

12553
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ADVANCES IN PROSPECTING SUBTLE POOLS IN CHINA

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 4, No 2, Jun 83 p 228

[Article by Dang Renshan [7825 0086 3790]]

[Text] Most of the large oil and gas reserves on land in eastern China have been discovered by exploration. The prospecting of various non-structural types of subtle pools has been gradually initiated with some success. In order to exchange experience and enhance the effectiveness, the Petroleum Geology Section of the Petroleum Society of China and the Petroleum Geology Society of Heilongjiang jointly sponsored a national meeting on the exploration of subtle pools, which was held on 20-26 April in Wuxi, Jiangsu.

Over 170 delegates from the Chinese Academy of Sciences, the Ministry of Petroleum Industry, the Ministry of Geology and Minerals, and higher learning institutions attended the meeting. Fifty-two papers were received and 20 were presented at the meeting.

Comrades from the Beijing Institute of Petroleum Exploration and Exploitation and oil fields in Daqing, Dagang, Shengli, Subei, Jianghan, and Changqing introduced the formation conditions, geological characteristics, distribution pattern, exploration history, and exploration methods of subtle pools of oil and gas which interested the delegates at the meeting. In recent years, a number of stratigraphic, lithologic, and complex oil reserves of considerable quantity have been explored in the regions mentioned above with good prospects for exploitation. They include some lithologic oil and gas reserves and stratigraphic overlap oil and gas reserves, lithologic upward inclined oil and gas reserves, ancient geomorphological oil and gas reserves, reef block oil and gas reserves, sandstone lens oil and gas reserves, and sandstone crack and volcanic crack oil and gas reserves. The exploration has been especially successful in the Sanzhao region of the Songliao Basin, Jiyang, the Huanghua Depression, the Liaohe western depression and the Qingyang area of the Shaanxi-Gansu-Ningxia Basin.

The authors of some of the papers investigated the formation mechanism and distribution pattern of subtle pools based on regional structure, sedimentary petrology, epigenetic effect, densification effect, organic evaluation, and hydrodynamic conditions and presented some new ideas. Most believed that major

subtle pools developed by different basins are different. Various paleogeological and paleogeomorphological environments controlled the formation of lithographic traps. The sand distribution of the same basin (depression) also has different characteristics in different areas. Erosion of a nonconforming face is an important condition for the formation of stratigraphic traps of oil and gas reserves. The stratigraphic and lithographic traps in a basin (depression) are usually distributed by groups and bands in a certain pattern.

We have acquired considerable experience in applying seismogeology to the exploration of oil and gas and number of achievements in this area have attracted a lot of attention. A seismological cross-section treated by various techniques not only can determine the presence of non-conformity faces, the states of various sands, and the range of stratigraphic overlap, but also can directly locate subtle pools of oil and gas by using markers such as bright spots and dark spots. In this regard, the delicate work on Huanghua, Jiyang, Subei, and Jianghan Basin received praise from the delegates. The authors of some of the papers also introduced and studied new exploration methods and techniques.

After all the papers were presented, the meeting was divided into Songliao, Bohai Wan and Subei groups for in-depth discussion. People talked enthusiastically and provided many valuable opinions with regard to the exploration of subtle pools in these three regions.

Noted geologist Huang Jiqing [7806 3078 3237], Ye Lianjun [0673 6647 0193], and Zhu Xia [4281 1115], as well as comrades Wu Chongjun [0702 1504 4596], Zhang Jiahuan [1728 1367 3883], Xu Huaida [1776 2037 1129], Tian Zaiyi [3944 0961 5669], Yang Zhaoyu [2799 0340 1342] and Gong Zaisheng [7895 0375 0581] addressed the meeting. They presented their viewpoints on locating oil in various basins in China based on multiple cycle, sedimentation phase, and plate theories.

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OIL, GAS CHARACTERISTICS IN SONGLIAO, DAQING OILFIELDS

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 4, No 2, Jun 83 pp 171-179

[Article by Yang Jiliang [2799 4949 5328]: "Characteristics of Oil Pools in Daqing Oilfield and Accumulation Regularities of Oil and Gas in the Songliao Basin"]

[Text] The discovery and beginning of exploitation of the Daqing oilfield dates back 20 years. We have accumulated a wealth of data through the exploration and opening up of that oilfield and through the exploration of the Songliao Basin and other areas, so we are able to recognize, and in a preliminary way master, certain laws of petroleum geology. This paper takes as a starting point a description of the conditions of the formation of the Daqing oilfields and the characteristics of its oil reservoirs; then, based on the land facies--fault depression basin features of the Songliao Basin we will further summarize the rules of accumulation of natural gas in the sediment of the depression period, in order to provide a basis for finding even more oil and gas fields in the Songliao and similar basins.

I. Geological Conditions for Oilfield Formation

1. Location near long-term, well-developed oil generating depression, with sufficient oil source

Daqing oilfield is located in the middle section of the central depression of the Songliao Basin, between two favorable oil generating depressions, Sanzhao and Qijia--Gulong; the entire oilfield lies within a favorable oil generating area of Cretaceous Qingshankou formations. On the west flank of the oil field is the Qijia--Gulong depression, a long-term, well developed oil generating depression, the central point for sedimentation and subsidence of Cretaceous Qingshankou formations, Nunjiang and other formations. The oil generating rock is 500 to 700 meters thick, total hydrocarbon content is greater than 0.2 percent, transformation series types of organic carbon are greater than 6 percent--a good quality oil generating rock. Songliao Basin's Cretaceous oil generating rock bodies amount to over 12,000 cubic kilometers, providing a rich oil source for the formation of large oil pools. Study of the content of normal paraffins, content of trace metallic elements, carbon

isotopes and principal-peak carbon, as well as other indicators, shows that the crude oil in the Daqing oilfield came mainly from the oil generating depressions on its two sides.

2. Located in the sedimentation sector of a large complex delta, the conditions were good for oil storage

The development of the sandstone of the main reservoir beds of the Daqing oilfield (Saertu, Putaohua, Gaotai, abbreviated "Sa," "Pu," and "Gao") was controlled by sedimentary bodies at the north end (Baichuan--Heiyupao--Xingshugang sedimentary bodies) which entered along the long axis of the depression in the center of the basin. The main part of the north section of the oil field is along the belt where the delta and the flooded plain facies join; sandstone bodies made of river course sand, branch stream river course sand, river mouth sand in sandbars and sheets at the front edge of the delta all are crisscrossed one on top of the other, forming a large complex delta. Of them, the first three mentioned types of sandstone are the more prevalent, with a single stratum being fairly thick, their oil storing nature is good, and they constitute the richest oil containing part of the Daqing oilfield. At the south part of the oil field, the sandstone of the Saertu and Gaotaizi oil reservoirs tapers out; the Putaohua reservoir comes from sedimentation in the delta's branch streams, on the plain, and shallow lakes on the banks; a single stratum of sandstone is fairly thin, there has been a fair amount of metamorphosism along the plane, and these small-scale structures, along with faults, are able to form effective traps.

3. The reservoir beds are squeezed between source beds top and bottom, forming a good oil source and storage caps

The main oil reservoir beds are squeezed between Qingshankou and Nunjiang formations, section one, and both are oil generating strata; sections two and three of Nunjiang formation and Qingshankou formation have metamorphosed into salutary oil producing black mudstone. Thus there is generation on the top, bottom, and sides, all causing oil and gas to migrate to and accumulate in the reservoir beds. The black mudstone of the Nunjiang formation, section one and two, reaches 300 meters in thickness, which makes for a good cap stratum.

4. Favorable conditions in large type long wall structure belts

The bottom structural form of Daqing oilfield's Nunjiang formation is made up of seven anticlines, each enclosing an area of 14.5 to 264 square kilometers and a height of 50 to 149 meters. Among them, the Saertu, Putaohua and Lamadian structures have the largest area and greatest height. All these anticlines belong to a unified secondary structure----the Daqing long wall. The long wall axis strikes roughly 20 degrees north to east, it is 145 kilometers long south to north and it is 10 to 30 kilometers wide, east to west. The area it encloses is about 2,800 square kilometers and it encompasses 524 meters in elevation. The east limb of the long wall structure has a

gradual dip of two to seven degrees; the west limb is more precipitous, with a dip of three to to ten degrees, and in the west wing of the Lamadian and Saertu structures the dip is 14 to 18 degrees, sometimes reaching 24 degrees; the ridgeline of the structure is level.

5. A good coordination of the times of the formation of the structure and the production and migration of most of the hydrocarbons

Before the sedimentation of the Qingshankou formation, the Daqing long wall had not yet formed. During the time of the sedimentation of the Yaojia formation and Nun, third section, the high points of local structures, such as Putaohua, Aobaota, etc., were already present in embryonic form. At the end of the sedimentation of the Nunjiang formation (about 90 million years before the present) the local structures had taken their basic shape and they joined to form an anticlinal belt. After the sedimentation of the Mingshui formation (about 70 million years before the present) they were a step further toward completion, and they formed the long wall. When the structures were developing and taking shape, the Qingshankou and Nun, section one, source beds in the neighboring depression reached the maximum depth (1,180 to 1,330 meters) for a source threshold. The Daqing long wall, rising up in the depression, provided a good place for the accumulation of hydrocarbons.

6. A large amount of slip-strike faulting and co-occurring faulting, beginning an important action for the migration and accumulation of oil and gas.

In the Lamadian, Saertu and Xingshugang areas of the north section of the Daqing oilfield core samples have confirmed that the top layer of the Putaohua source bed has been faulted along 353 lines; in the south section, according to seismic data, the Taipingtun, Gaotaizi, Putaohua, and Aobaota areas, there are 291 fault lines along the bottom side of the Nunjiang formation. These 644 faults are all normal faults. They span 20 to 60 meters, with the largest 220 meters; they extend for a length of 1 to 3 kilometers, with the longest 13 kilometers. These faults can be divided into two types: one is the non co-occurring slip-strike fault; the other is the co-occurring fault. The former occur mainly in the north part, where the limb is steep and the axis is fairly developed; the faults strike roughly north to west, fairly flat and straight along the strike; to the two sides of the faults the thickness of the Yaojia formation remains unchanged; the associated tension joint pattern faces have been filled in everywhere with pale khaki colored or brown colored asphalt, paraffin, and oxidized oil; these faults were formed rather late, their main action was to serve as a conduit for the migration of the oil and gas. The latter are chiefly distributed in the south part of the oilfield; besides those that strike north to west, there are a few that approach a south to north and north to east direction, the fault lines roughly constitute serpentine curves or arcs; on the two sides of the faults the thickness of the Taojia formation and the Nunjiang formation, section one and two, clearly has deficiencies and differences, the footwalls everywhere have occurences of Putaohua source beds locally increasing the thickness; the joints associated with the faults often have been filled in by mud and sand from neighboring strata; these faults provided good trapping action during the course of the migration of the oil (Fig. 1). [1]

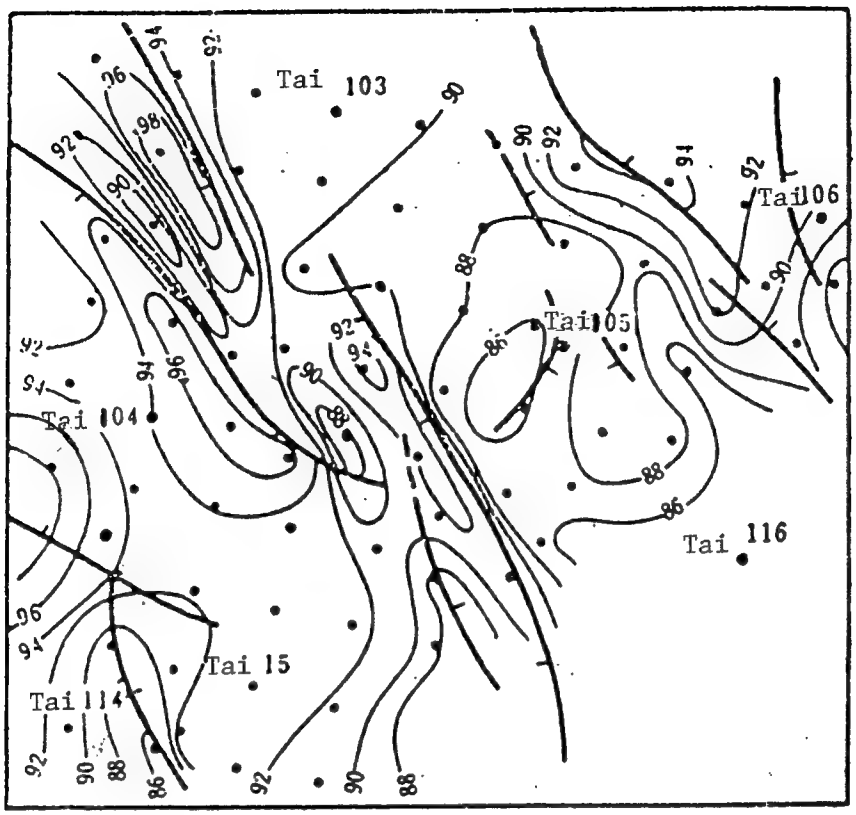

Figure 1. Co-occuring Faulting on the Daqing Long Wall

II. Properties of the Reservoirs

The oil pools of the Daqing oilfield are generally secondary structural belt controlled, with the whole body holding oil. However, a major reason for the difference between the course of the enrichment and the differences in types of oil and gas pools in the south and north parts of the Daqing long wall is the difference in development of oil collecting beds.

1. Large structures are well coordinated with thick sandstones, forming the north section's massive oil pool structures

On the north part of the Daqing long wall, the Yaojia formation and the Qingshankou formations (sections 2 and 3) are situated on the large complex delta made of sedimentary bodies. Sandstone is well developed; well samples to depths of 300 to 500 meters and more have shown to be nothing but sandstone and mudstone in alternating strata. Lamadian, Saertu, and Xingshugang are all anticlinal structures of large area and grand scope. The coordination of these two aspects caused the formation of structurally controlled oil and gas pools (Fig. 2). Special features of these oil and gas pools are that the amount of oil and gas held within a particular structure is controlled by the height of

the structure; and they have unified oil-gas interfaces and oil-water interfaces. From top to bottom in sequence there occur pure oil sections (sometimes with gas caps), thick oil sections, oil-water transition sections, and water sections. Generally there will be no water-holding strata within the pure oil sections. The depth of the oil-water interface on either side of the faults is the same, and the pressure system is equal throughout the entire oilfield. The area and the depth of oil held in these oil pools is very great. The three oil fields of the north sector contain oil in every case more than 200 meters deep. The thickness of the oil strata is generally greater than 20 meters, with the largest more than 50 meters. The unit-area geological accumulation is comparatively great. This has created the richest oil deposits in the Daqing oilfield.

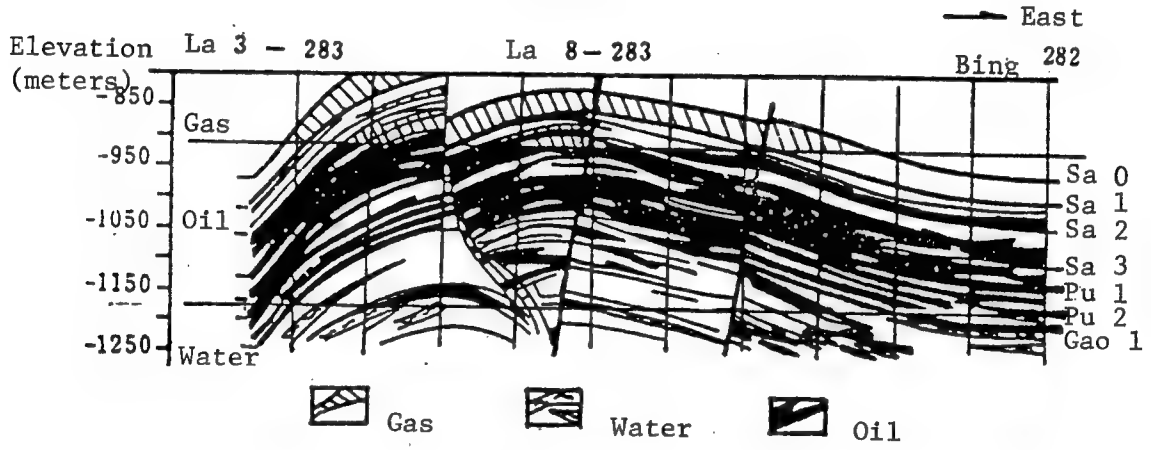

Figure 2. Cross-section of Lamadian Oil and Gas Pools

2. Many faults are coordinated with thin sandstone, creating the fault complicated structural oil pools of the south sector

The structural conditions of the south sector of the Daqing long wall (such as the Putaohua structure) are not much different from those of the north sector. In this area sandstone occurs only at the 40 to 60 meter section of the Putaohua oil strata. Individual stratum are 1 to 3 meters thick, with a total thickness of 10 meters. Faults with a span of 20 to 30 meters show fairly good trapping action. In particular there are rolling anticlines formed on the bottom plate of the co-occurring faults, even better for enrichment areas, such as at wells Pu 164, 165, 144, 200 Ao 26, and Fang 4 (Fig. 3). Intersecting faults in the direction of the depression may also form useful traps, as at wells Pu 206, Pu 289, and Tai 20. Thus, the amount of oil held in this area is controlled by anticlines, which hold fairly copious quantities of oil in their top sections. At the same time, the faults also create some trapping action. This caused each fault area to have a distinctive oil-water interface, with a oil-water interface of a different height in a neighboring fault area. The occurrence of oil and water in this sort of oil pool is rather complicated. On the lower parts of higher fault areas water zones can be found; on the higher parts of lower fault areas oil

zones can be found. The surface area of pure oil zones is normally not great. Besides this, owing to the sandstone being fairly metamorphosed along the plane, rock traps or rock complex traps may be formed in places. A cross section shows that oil and water strata are intermixed. In fault-complicated structural pools the oil strata are fairly thin, and the unit-area accumulation is fairly small.

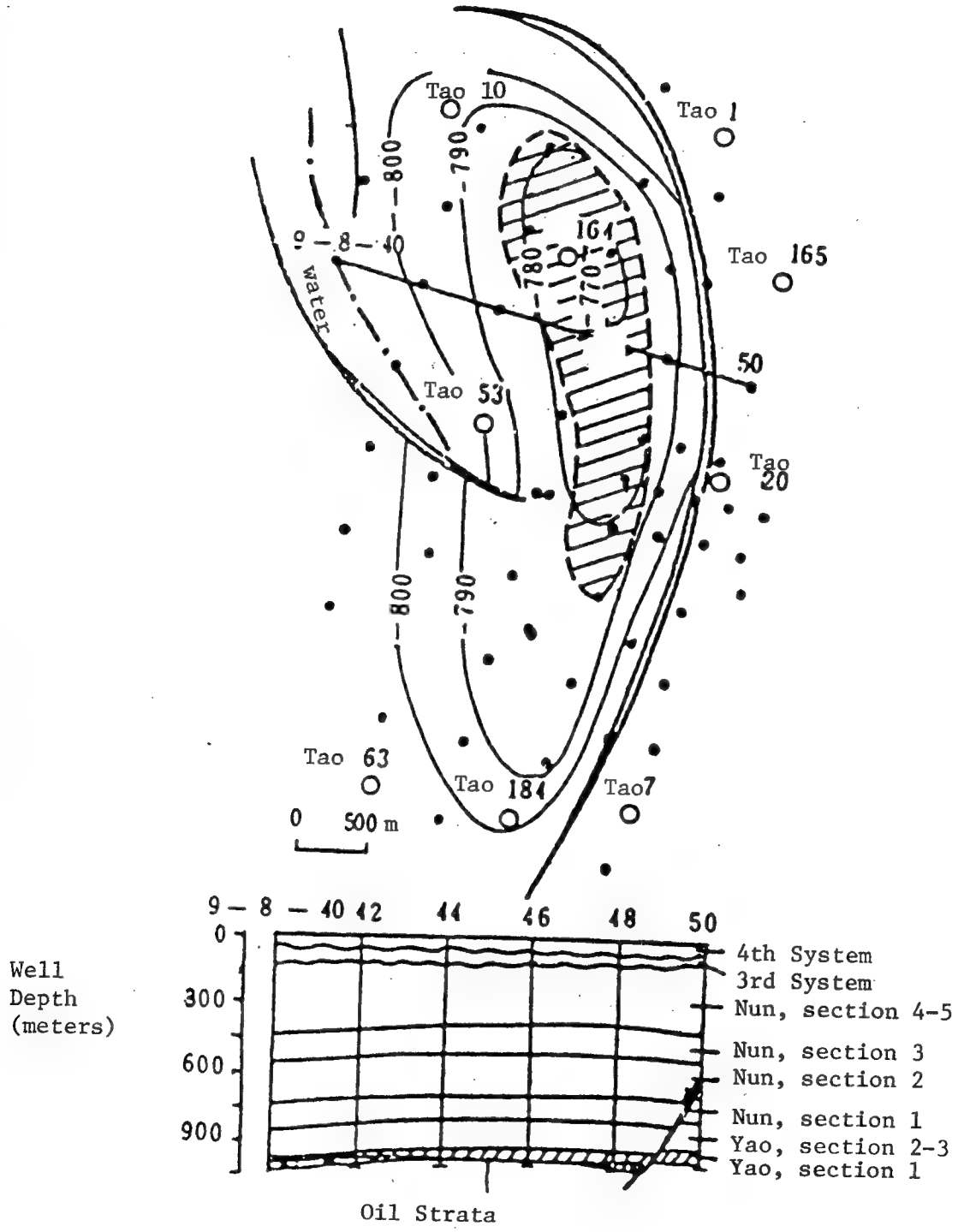

Figure 3. Oil Pools on the Rolling Anticline of the Southern Sector of the Daqing Long Wall

3. The entire secondary structural belt controlled body contains oil

Sometimes the height of the oil held in the three oilfields of the north sector of the Daqing long wall is greater than the height of the structure's enclosure, forming inter-structural saddle area continuous oil bearing tracts. In the south sector of the long wall, the variations of the height of the oil-water interfaces are rather great, but the lowest is not lower than -1,000 meters. This is another reflection of the importance of the secondary structural belt controlled oil and gas collection (Fig. 4).

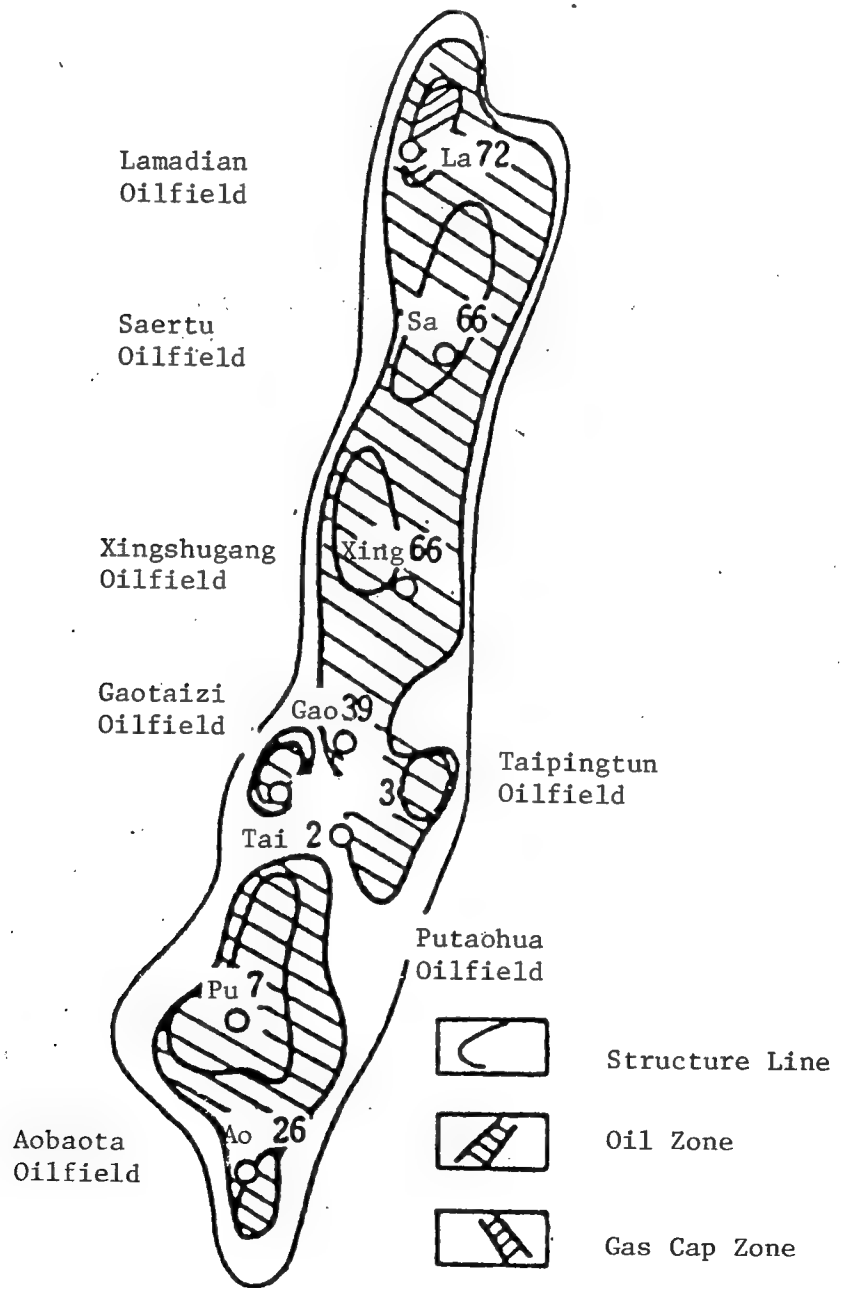

Figure 4. Occurance of Gas and Oil Pools on the Daqing Long Wall

4. The correlation of reservoir pressure to saturation pressure in oil strata of different periods created different conditions for gas-oil separation.

Over the course of paleo-tectonic development, when the pressure in the gas and oil reservoir beds exceeded saturation pressure, the gas was dissolved in the oil, gas caps did not appear. When the pressure in the reservoir beds was less than saturation pressure the gas was stripped from the oil and formed gas layers or gas caps. In the Daqing oilfield, there is a tendency for a variation in saturation pressure: high in the north and low in the south. The Putaohua reservoir can be used for an example (Table 1). After the sedimentation of the Nunjiang formation the reservoir pressure was always higher than the saturation pressure in Putaohua reservoirs in several structures in the south sector of the Daqing long wall, and no gas caps were formed. In the north sector on the Lamadian structure, the reservoir pressure was for a long time lower than the saturation pressure in the top of the reservoir; and thus was formed a primary gas cap. A special characteristic that can be seen in rock core samples is that it is a clean pure gray-white sandstone or brown sandstone; the special characteristic of the gas content is that it is high in methane (92--96 percent), and very low in ethane and heavier hydrocarbons (less than 2 percent); the specific gravity is low (less than 0.6 percent). Because the tectonic action at the close of the Nunjiang era and the Mingshui era caused the Saertu structure to rise up and be denuded, and even caused the reservoir pressure in the Saling formation at the top of the structure to be lower than saturation pressure, the gas stripped from the reservoir formed a secondary gas cap. The make-up of this natural gas in this kind of secondary gas cap falls between that of the primary gas cap and that dissolved in primary oil: methane is about 90--94 percent, ethane and heavier hydrocarbons are about 2--5 percent. In addition to these structurally controlled gas caps, the sandstone in the Saling formation of the Saertu oilfield often forms striplike occurences scattered about, and in these can be formed secondary rock and structure controlled gas reservoirs.

TABLE 1: Saturation Pressure in Putaohua Oil Strata of Daqing Oilfield

Oilfield	Primary Saturation Pressure (in Atmospheres)	Primary Oil-Gas Ratio Cubic Meters/Ton
Lamadian	104.9	48.5
Saertu	91.0	47.2
Xingshugang	75.6	44.4
Taipingtun	68.0	40.4
Gaotaizi	69.3	40.5
Putaohua	64.0	45.4
Aobaota	76.5	44.4

5. The crude oil exhibits the characteristics of continental facies high-paraffin low-sulfur oil. The common characteristics of the crude oil in the Sa, Pu and Gao reservoirs of the Daqing oilfield are: paraffin content fairly high, sulfur content fairly low, carbon isotope delta-^{13}C value fairly low (-2.68 to -2.83 percent). In areas near the vertical oil-water interfaces, the specific gravity and viscosity of the oil have clearly been raised; in flat oil containment interface areas the specific gravity and viscosity of the crude have clearly been raised. This is a reflection of the characteristics of structural oil pools. In addition, we may see from the nature of the crude oil from the middle of structures that have not undergone any definite oxidation that, proceeding from south to north in the oilfield, the specific gravity and viscosity of the crude increases, the paraffin content decreases, the amount of colloids increases, their sulfur content increases slightly, the saturated hydrocarbon content decreases, and non-hydrocarbons and asphalts increase. These differences may chiefly reflect the differences in oil generation conditions in the north and south of the Qijia--Gulong depressions; they also reflect through their definite course the possibility that the oil generated in the south migrated north (Tables 2 and 3).

TABLE 2: Qualities of Crude Oil from Putaohua Oil Strata, Daqing Oilfield

Oilfield	Well	Specific Gravity $D^{20}/_4$	Viscosity (Centipoise)	Melting Point (Degrees C)
Lamadian	La 72	0.870	32.3	24
Saertu	Sa 15	0.869	29.0	31
Xingshugang	Xing 54	0.852	19.3	23
Taipingtun	Tai 2	0.850	12.9	25
Gaotaizi	Gao 6	0.855	16.8	25
Putaohua	Pu 7	0.839	10.7	25
Aobaota	Ao 26	0.854	27.6	24

Oilfield	Well	Paraffin (percent)	Colloids (percent)	Sulfur (percent)
Lamadian	La 72	21.2	20.8	0.060
Saertu	Sa 15	20.2	18.1	0.066
Xingshugang	Xing 54	21.0	12.6	0.057
Taipingtun	Tai 2	32.5	6.3	0.034
Gaotaizi	Gao 6	30.4	8.1	0.045
Putaohua	Pu 7	28.4	6.3	0.034
Aobaota	Ao 26	23.9	8.6	0.038

TABLE 3: Composition of Daqing Oilfield Crude Oil Family

Oilfield	Total Hydrocarbons (percent)	Saturated Hydrocarbons (percent)	Aromatic Hydrocarbons (percent)
Lamadian	81.9	57.1	24.8
Saertu	78.8	62.6	16.2
Xingshugang	84.8	66.3	18.5
Gaotaizi	87.1	71.6	15.5
Putaohua	89.0	70.1	18.8

Oilfield	Non-Hydrocarbons and Asphalts	Saturated Hydrocarbon to Aromatic Hydrocarbon Ratio
Lamadian	18.1	2.30
Saertu	21.1	3.86
Xingshugang	15.2	3.58
Gaotaizi	12.8	4.62
Putaohua	11.0	3.73

6. Cutting by faulting created secondary oil and gas pools

The faults in the Daqing oilfield generally cut through the important oil and gas holding strata, their upward extents cutting through the reservoir beds and cap rock of the Nunjiang formation, section one and two, and some even continue on to the Mingshui formation. Because of the conduit action of the faults, the oil and gas may migrate even higher, to accumulate in the top part of the Sa section two, three and five, and even in the Mingshui formation, forming secondary oil and gas pools. These are still primarily structure controlled. In shallow strata, oil and gas indicators producing oil and gas wells occur in the vicinity of faults in the top of the structure. In the north part of the oilfield these secondary pools are even more common. Two sets of conditions can be delimited based on differences in the cap rock: when the mudstone of the Sa, third section, forms a fairly stable cap rock, the gas-containing reservoirs in the top part of the sandstone of Sa, second section, are also fairly stable, and normally in the high part of the structure gas will be contained only if sandstone occupies this position. Above the Sa, third section, because there is no thick and stable mudstone cap rock, the sandstone lenses out, it is not permeable, the position of oil and gas reservoir beds is unstable, the separation of oil gas and water is not good, forming wedged out oil strata, gas strata or mixed oil and water strata.

To conclude, it may be seen that the typology of the Daqing oilfield oil pools is rather simple, anticlinal structural factors created the most important action for oil and gas pool formation; the lithologic, faulting, and other factors created definite action in certain places, thus were formed structural gas and oil pools as well as various types of complex pools.

III. Basic Rules of Oil and Gas Accumulation in the Songliao Basin

The Songliao Basin is a stable massif interior fault and depression complex type basin. The basin underwent four stages in its formation and development: scattered faulting depression in the Jurassic; fissure-valley type faulting depression in the Denglouku Age of the Cretaceous; large-scale col depression from the Quantou to the Nunjiang in the Cretaceous to the Tertiary. Important manifestations of structural activity are: fault fissuring in the early period; sedimentation in the middle period; folding in the late period. The structural conditions are not the same for strata at various levels. This results in differences in sedimentation characteristics, types of traps, and oil and gas occurrence. When the basin was in its height of development, the primary rock for generation and accumulation was formed.

1. The generation zone controls the occurrence of gas and oil, the oil and gas generally migrated only a short distance, the richest oil accumulation is that in reservoir beds neighboring favorable generating beds.

From the time of the sedimentation of the Quantou to the Nunjiang stages, and after that sedimentation, the large-scale fissure faulting of the Songliao

Basin was clearly weakening. After the oil and gas was formed it for the most part migrated from the generating bed to neighboring accumulating beds, thus the oil reservoir beds of Saertu, Gaotaizi,and Putaohua, located among the good oil generating beds along a north-south line, are the accumulating beds already known to hold the most volume. They are differentiated from the Fuyu, Yangdachengzi, and Heidimiao oil strata which lie above and below the generating beds and which are important oil and gas strata.

On the plane surface, due to rather extreme metamorphosis of land facies sedimentary rock, the permeability of the sandstone is not good and it is comparatively difficult for oil and gas to migrate any great distance, so the richest concentration of oil and gas is within the generation zones and next to the zones. Known oilfields, zones with commercial pumping of oil and gas already going on, and reconnaissance wells showing good indications are generally all within the boundaries of the oil generating zones and environs. Previous data had indicated that the vicinity of good oil generating depressions, such as Qijia--Gulong, Sanzhao, Changling, etc., was always the zone containing the richest amounts of oil and gas. In recent years it has been discovered that local oil generating depressions with even better oil generation conditions lie within the good oil generating zone, for example the eastern part of the Sanzhao zone, and fairly rich oil-holding zones could be formed next to them. Therefore, finding the good oil generating zones and the excellent local oil generating zones is of practical significance in directing exploration. Further, according to analysis of oil indications and of oil pumped from Saertu oil strata in Fulaerji and other areas, there does exist some oil which migrated rather long distances.

2. Lakeshore transition belts are favorable to oil and gas accumulation

Three important types of sedimentation are included in the lakeshore transition belt. Those types are: large complex delta; rapid transition small delta; and lakeshore cove deposits. Sand types include: side stream plains river course sand, breached fan sand, river mouth sandbar sand (foliate bodies), sheeted sand, littoral shallow lake lensing sand, as well as river course sand, biogenic clastic rock, and others. The lakeshore transition belt became a favorable place for oil and gas accumulation for the following reasons: 1) It is adjacent to the deep lake facies oil generating rock, and the oil and gas at the very first entered into this type of accumulating bed; 2) The accumulating bed is rather developed, there are many strata of sandstone and biogenic clastic rock, and its ability to accumulate oil substances is generally good; 3) Sandstones, biogenic clastic rocks and mudstones form interstratified beds, faults of small gap and anticlines of small scale all may form favorable gas and oil traps; and 4) The permeability of the accumulating beds is fairly deficient, the sandstones show wedging or peter out to one side, making it easy to form rock traps.

The southern part of the Taikang upheaval, Longhupao, and areas south of the Shengping--Changde areas of the Sanzhao depression all belong to the lakeshore transition belt of northern sedimentary bodies. The Honggangzi--Taian area

belongs to the lakeshore transition belt of Yingtai sedimentary bodies from the west. The oil pumped from these areas has gone a bit further toward illustrating that lakeshore transition belts are favorable places for the accumulation of oil and gas, and are important areas for oil and gas exploration. Good oil and gas accumulation beds may also be formed in the thick strata of river course sandstones of the flooded plains if there are large scale structural traps.

In recent years oil indications or producing wells have been found in other types of accumulating beds as well. The principal ones are: biogenic calcareous rock (well Du 402), turbid sandstone (wells Ta 2 and Ying 10), mudstone rifts (wells Da 111 and Ying 12) and weathered bedrock muschel (Zhaoshen 1).

3. The oil production threshold is shallow, and post rock formation production was fairly strong

According to studies of the rules of natural transformation of the casein in the cross section of the Songliao Basin [2], and of the divisions of gas and oil producing segments, the depth of the oil production threshold from Qing, section 1, to Nun, section one, is 1,100 to 1,400 meters. Shallower still, organic matter is located in immature sectors, the principle product of which is methane gas. At a depth greater than the threshold but less than 1,700 meters, organic material is located in sectors of low maturity, their product being mainly heavy crude. At 1,700 to 1,900 meters we come to the high peaks of oil generation. From 1,700 meters to 2,700 meters organic materials are assembled in sectors that are past maturity, and these produce dry gas. The depth of the oil threshold and of oil generating peaks is clearly less than that of the Bohai Bay and other basins. Because the depth at which sedimentary materials in the central depression zone has not been appreciably altered by later structural activity, the above mentioned depths basically reflect the limits for the occurrence of different oils and gasses, and this has been confirmed through exploration. For instance, well Ying 3 brings in hydrocarbon oil with a specific gravity of 0.8040 from a well depth of 2,350 meters; wells Zhaoshen 1 and Xing 4 produce gas at depths always greater than 2,800 meters.

There is a great area of Qingshankou oil generating rock in the Gulong depression which is buried at depths greater than 2000 meters, but in the Sanzhao zone it is not at the depth for full maturity. This points up the reason for the difference in oil and gas volume in these two areas.

According to studies of the rules for the formation and changes of sandstones and clay minerals[3], when the depth is greater than 1300 meters and the middle rock forming sector is entered, owing to clear strengthening of secondary increases in the size of the quartz in the sandstone and the appearance of intermixed strata of clay minerals, changes in the oil accumulating nature are indicated. At depths greater than 2000 meters, empty cracks in the sandstone are less than 10 percent; at depths greater than

3000 meters they are less than 5 percent. Under the influence of a fairly strong post-rock formation generating action, the distribution of the depths of favorable oil accumulation strata in the Songliao Basin is clearly less than that in areas in North China.

4. Stable regional cap strata create trapping conditions over a wide area

In the Songliao Basin, the Cretaceous Nenjiang formation, sections one and two, and the Qingshankou formation, section two, are two fairly thick and fairly widely occurring black mudstones, with a thickness of 80 to 300 meters and an area of over 80,000 square kilometers, forming two stable regional cap strata. This is favorable to the preservation of oil and gas in the Saertu oil stratum and each oil stratum beneath it. The Nen, section three, lacks a good cap stratum above it, so the position of the occurrence of oil is not stable.

In parts of some areas there occurs a fairly stable mudstone of a definite thickness, and that may act as the separating stratum, with definite trapping conditions for that area. For instance, in the Taikang area new compositions of oil, gas and water may appear, because there is a black mudstone stratum 5 to 15 meters thick in the top and middle parts of Qing, section two and three. Both Well Du 402, atop the Baiyinnuolei structure, and Well Du 202 on the footwall of the rolling anticlinal structure beneath the Xindian arc-shaped faulted strata fit this scale (fig. 5). The closure of the two structures is only 15 to 30 meters, creating oil and gas well sections that stop and start over distances of up to 200 meters, forming local rich oil and gas reservoir strata in small-span structures.

5. Relatively stagnant groundwater is favorable to the preservation of oil and gas

Each of the Sa, Pu and Gao oil strata, all sedimentary systems coming from the edges of the basin, pinch out in the direction of the center of the lake basin; in the area of the denuded strata in the southeast part of the basin, corresponding strata have all metamorphosed into large sections of mudstone. The absence of a clear sluicing zone forms a trapping hydrological-geological system.

There is no great difference in the strata water pressure in the Songliao Basin. There is only a 150-meter difference in water level from Beian in the north and of the basin to the Sanzhao zone, the water level drops an average of 0.6 meters per kilometer. Since there is no clear sluicing zone, and the difference in pressure is so small, the groundwater is not terribly active. In the center part of the basin, where it is buried deeper, the mineralization of the strata water is increased due to concentration.

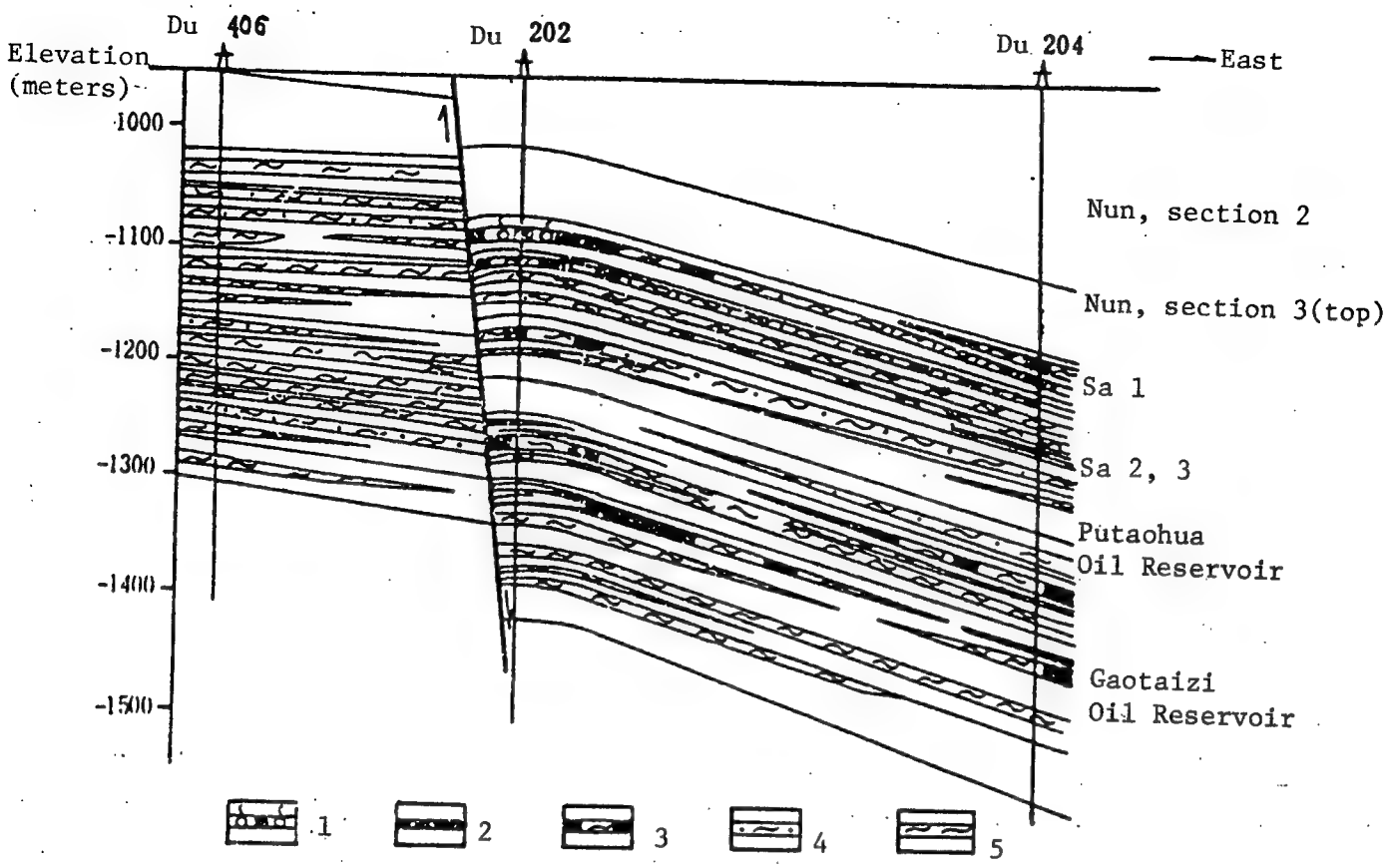

Figure 5. Cross-section of Xindian Oil Pools

Key:
1. Oil and Gas Strata
2. Oil Strata
3. Mixed Oil and Gas Strata
4. Water Strata (with oil indications)
5. Water Strata

On the surface, there are definite rules for the changes in the quality of strata water. Following along the relatively developed part of the sandstone in the center of each sedimentary system from the outer edge of the basin to the center part we see increases in total mineralization, content and proportion of chlorine ions, and salts; and a decrease in carbonates and recrystallized carbonates. The water type is usually recrystallized sodium carbonate type (Fig. 6). In the center of the basin, when the mineralization of the strata water exceeds 4 grams per liter, the proportion of chlorine ions is greater than 20 percent, and the salinity index is greater 1 (or greater than 0.7), then it is common to see oil indications in that zone. In zones where the mineralizaiton is less than 4 grams per liter, then oil indications are basically absent or deficient. In those oilfields and pools that have been discovered, the large majority have a strata water

mineralization of greater than 6 grams per liter; only that of the Fulaerji oil pool is around 4 grams per liter.

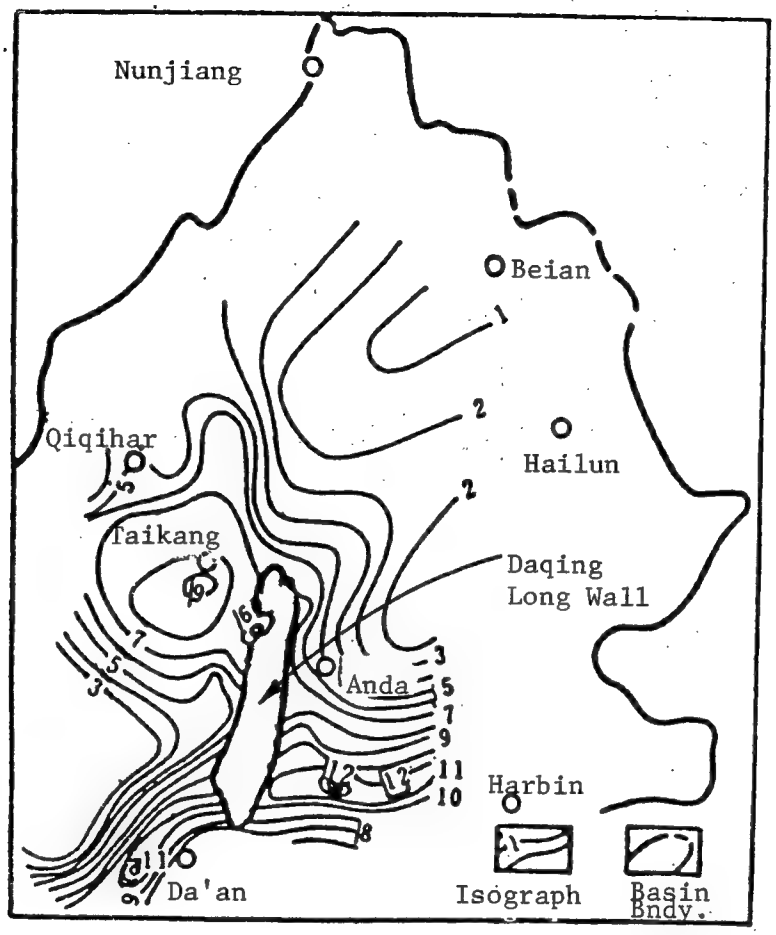

Figure 6. Degree of Mineralization of Strata Water in Late Cretacious Yaojia Formation in Songliao Basin

There is a definite relationship between the properties of the strata water and the presence of oil. If the strata water in a zone is highly mineralized, the proportion of chlorine ions is high, the content of recrystallized carbonates and carbonate ions is low, and the extent of concentration in the water is high, then conditions are favorable for the presence of oil. Consequently, we may have reference to hydrogeological conditions to point out places favorable to the accumulation of oil and gas.

6. There is a variety of traps and a variety of pool types

As a consequence of the penetrating work of exploration, it has been discovered

that many types of trapping conditions co-exist in the Songliao Basin, forming a variety of oil and gas pool types. In the main, these types are as follows; (1) Anticline structure controlled pools, including massive anticline structural oil and gas pools (such as the north part of the Daqing Oilfield) and strata structure oil and gas pools (such as the Longhupao Oilfield). (2) Oil pools formed mainly by fault traps or faulted block traps, including co-occurring faulted rolling anticlinal oil and gas traps (such as Xindian) and faulted block pools (such as the Xinmu Oilfield). (3) Faults, stoss and lee structures or small scale structures with the properties of the rock generally controlling the formation of oil and gas pools (such as Xinmu Oilfield). (4) Oil pools controlled by factors in the property of the rock, including oil pools formed by the sandstone petering out on the top (such as Fulaerji), oil pools in lenticular bodies of sandstone (wells Wei 1, Putaohua reservoir and Ta 2, Jingsaling formation). (5) Oil pools controlled by factors in the bedrock (as in the Zhaozhou batholith weathered bedrock gas pool). (6) Oil pools formed by trapping due to supercomplex strata or non-conformities and other factors. (7) Hydrodynamic trap oil and gas pools. The last two mentioned types have been predicted, based on analysis of the geology of the Songliao Basin. In the deep depression, around the batholith and in the western part of the basin there exists the possibility of the presence of strata trapped oil pools. On the edge of zones with low levels of mineralization in the water or on the limbs of anticlinal structures in the north part of the basin there is a possibility of the formation of hydrodynamic trapped oil pools. Beyond these, there are also secondary oil and gas pools in the shallow strata at the high point of some anticlines or in fault block structures, with rifts for conduits and fairly stable mudstone for caps.

Whether or not any of the above mentioned traps will be able to accumulate oil and gas depends on the type of sand bodies, regional hydrodynamic conditions, structure of empty spaces in the accumulating bed, and the relative height of the trap, as well as the time of formation of the trap and its coordination with the time of the formation of the greater part of the oil and gas in the neighboring oil generating depression.

7. Secondary structural belt-controlled oil and gas accumulation

Within the bounds of a secondary structure belt there are generally similar generation, accumulation and capping conditions, so several common reservoir beds and similar types of oil pools may be formed, that is, secondary structure belt controlled oil and gas accumulation controls the occurrence of similar types of oil and gas pool. Thus similar types of oil and gas pool generally are found in clusters and lines. If in a secondary structure belt we discover a certain type of oil or gas pool, then we may predict the possibility of the presence of several other similar types of oil pool.

In the course of exploration work, it has been discovered that in addition to the anticlinal structure belt (long wall), there are several other types of secondary structural unit oil accumulations, chiefly of these five types:

(1) Fault-obstructed belts. For instance, there is the Xiaolinke--Aogula--Halahi rift belt extending over 80 kilometers on the western edge of the Qijia--Gulong depression, and either side of that belt has many faulted stoss, rolling anticline and fault block traps, forming an oil and gas accumulating belt.

(2) Fault--stoss and lee belt. On the west side of the Daqing long wall there is a stoss and lee structure belt, striking toward the oil generating depression. Faults cut the stoss belt vertically or obliquely forming favorable traps, which when coordinated with the properties of the rock and other factors, form oil accumulating belts.

(3) Large stoss and lee structure belts. The well-matured Taikang stoss upthrust, trending into the Qijia depression and the Wuyuer depression, forms a oil and gas accumulation zone which is controlled by all sorts of small scale traps, and by the guiding of the migration of hydrocarbons produced in the oil generating depression along the top edge to the stoss upthrust.

(4) Fault--lithologic trap belts. On the slopes of the east and west sides of the basin the top edge of the sandstone will peter out locally and the faulting is super-complex, which may form gas and oil accumulation belts.

(5) Lithologic--small scale structure complex trap belts. These occur mainly in the Sanzhao and Gulong oil generating depression zones, and after the oil and gas was produced, a part migrated to a large scale secondary orthosyncline structure, and another part did not make that comparatively long-distance migration, but migrated to small scale anticline structures between the synclines, and there being places with faulted stoss structures, fault block structures, lenticular sandstone bodies and fairly developed faults, a rich oil containing belt was formed.

The characteristics of the occurrence of oil accumulating belts in the Songliao Basin, and the pattern for the occurrence of each type of oil pool are mainly controlled by two factors, structure and sediment. Having anticline structure and fault-obstructed oil and gas accumulating beds, and structural--lithologic complex oil and gas accumulating beds arranged one after the other in row, or the same oil and gas accumulating belt having reservoir beds with different levels of development or structures with different characteristics creates real differences in the presence or absence of oil pools.

In the Songliao Basin there are many oil bearing strata systems, many kinds of reservoirs and many kinds of oil and gas pools. At present the level of exploration is high only in the Sa, Pu, Gao and Fu oil strata; the priority has been to drill exploratory holes in most of the fairly obvious anticline structural traps. In the future the object for exploration will be finding concealed pools and other fairly complex oil and gas pools. In that work we must select an exploration program which is appropriate to the characteristics of the Songliao Basin, import or modernize our technology, ceaselessly

summarize our experience, and we must then certainly find even more oil and gas pools, to further develop the petroleum industry and provide reserves of natural resources.

(Manuscript received 5 November 1981)

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12663
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OILFIELDS IN KARAMAY OVERTHRUST BELTS EXPLORED

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 4 No 2, Jun 83 p 235

[Article by Zhao Bai [6392 4101]]

[Text] Along with the progress in oil exploration, the formation and evolution of the Karamay overthrust belt and its correlation to oil content has gradually received the attention of Chinese and foreign petroleum geologists. In late March, the Xinjiang Petroleum Management Bureau, the Petroleum Exploration and Exploitation Research Institute in the Ministry of Petroleum Industry and seven institutes in the geological institute of the Chinese Academy of Sciences held a "1983 Scientific Research Collaboration Meeting" on petroleum prospecting research work in the Junggar Basin at Karamay, with the formation mechanism of the overthrust belt and its relation to oil and gas being one of the subjects.

The Karamay overthrust belt is located on the northwest fringe of the Junggar Basin. It extends from Chepaizi in the southwest to Xiazijie in the northeast. It is a large arc-shaped hidden overthurst belt.

In the early sixties, there was some preliminary understanding of the rough shape of the overthrust belt. However, because of limited survey standards, only the characteristics and reserves in the Ke-Wu overthrust belt were known. It was believed to be a large angle overthrust fault, mainly developed in the Triassic system. The correlation between oil and gas with its formation and development was studied. The pattern for high crude oil yield in a fault zone was summarized, which guided the exploration of oil reserves along the Triassic plate fault with good results.

As we were introduced to more advanced exploratory techniques, exploration of the fault zone became deeper in terms of seismological exploration, drilling exploration, and well testing, and the level of research continues to improve. By the end of the seventies, the understanding of the fault underwent a quantum jump. The fault was clearly identified as a overthrust fault. The fracture pitch is 80-60 degrees in the shallow layer and becomes more gradual to 40-30-20 degrees; the smallest known angle is only 10-5 degrees. The fracture has a plow-shaped configuration which is steep on top and gradual on the bottom with the concave side facing up. The vertically projected belt width of the known fault reaches 10-20 kilometers. The fracture includes Jurassic,

Triassic, Permian, and Carboniferous systems. Because many secondary faults developed along both sides of the main fault, various wedges and diamond-shaped fault blocks were created. These fault block structures frequently form their own independent oil containing systems.

On the cross-section, the primary and secondary faults overlap each other. When an exploratory well is drilled in the fault belt or fault block, it is possible to hit multiple oil systems which overlap one another. Furthermore, due to the development of crevices in the fault structure, the storage characteristics of the oil-containing layer is improved, making it easier to create an oil and gas rich belt. Based on this understanding, the production department concentrated its effort to complete an overall exploration along the Ke-Wu fault. Within 2 years, the area containing oil was enlarged and the oil reserve was increased. In addition to the discovery of the Baikouquan Oilfield on the northeast side of the fault, many new oil producing wells were drilled along the fault. Many "hat brim" oil reserves were discovered to connect the oil reserves along the Ke-Wu fault as a belt. At the same time, exploration along the Xia-Hong fault--northeast of the fault--was initiated. Because of improved theory, liberated ideology, and widespread viewpoint, the mystery of this fault was revealed. It is not only similar to the Ke-Wu fault in terms of formation, evolution, and oil-bearing characteristics, it also has its own special character, i.e., the nappe structure. The main fault has a folding structure. The leading edge of the main fault has a fault block structure. These formation causes and internal correlations with the main structure have already been proven to be places where oil and gas cumulate.

Exploration is currently underway and new oil-producing wells have been drilled in Carboniferous, Permian, Triassic and Jurassic systems. It is predicted that new oil fields will be born along this overthrust fault belt.

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POSITIVE OIL PROSPECTS IN QINGHAI'S QAIDAM BASIN

Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese
Vol 5 No 2, Jun 84 pp 79-88

[Article by Di Hengshu [3695 1854 1859] of the Geological Institute of the Qinghai Oil Administration: "Overthrust Belts on the Northern Margin of Qaidam Basin and Their Oil Prospects"; manuscript received 2 Sept 83]

[Text] There is an overthrust belt striking northwest to southeast along the northern margin of the Qaidam Depression and the abutting areas of the Nan Gilian Shan made up, from west to east, of the Sainan, Lünan, Xinan, and other reverse faults and overthrusts, stretching to an overall length of 375 kilometers. The fault zone was cut up into different divisions by the Qianxi, Donggu, Yaxi, and other faults that come at right angles (Figure 1).

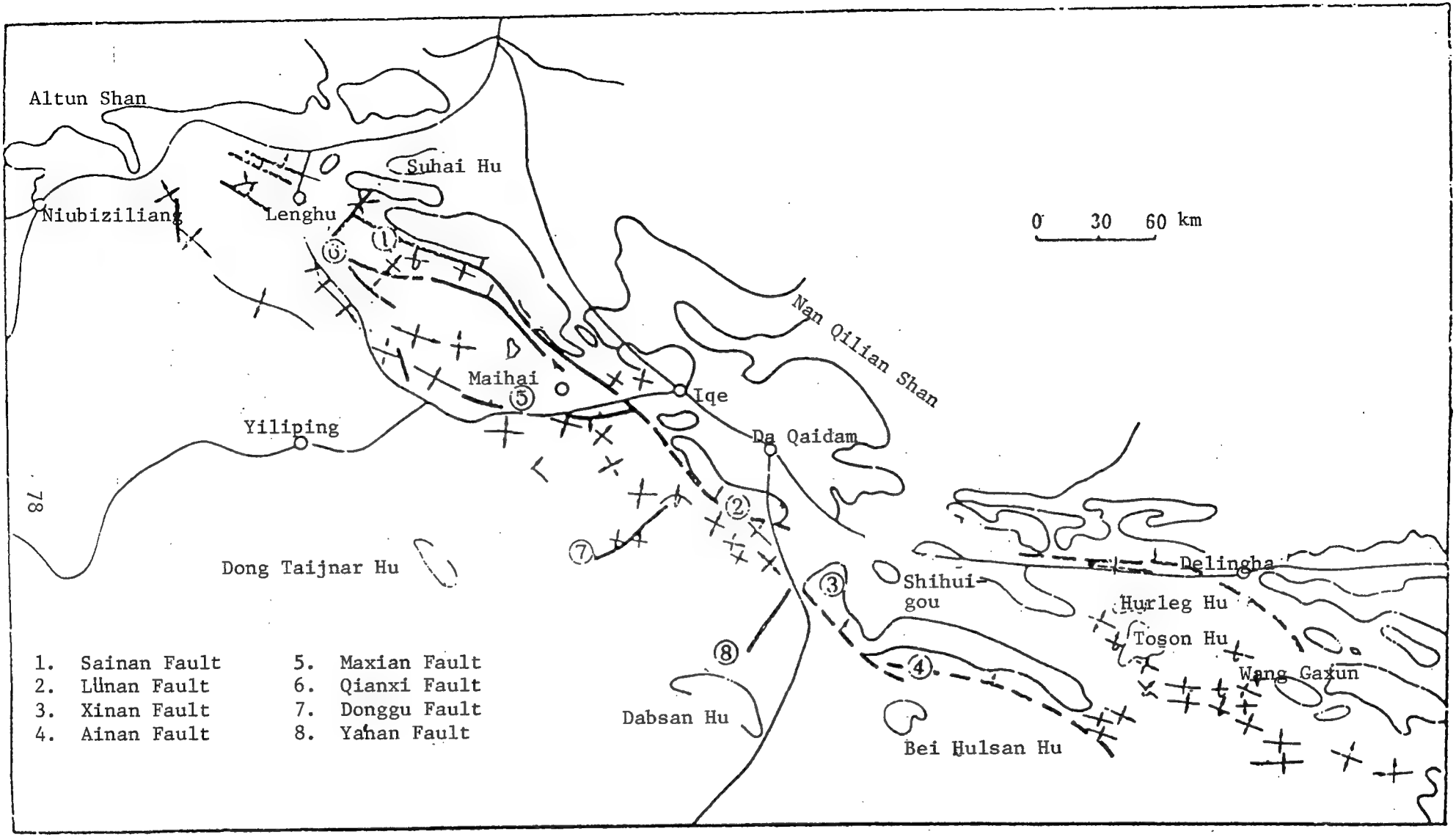


Figure 1. Map of distribution of principal faults on the north margin of the Qaidam basin. Solid lines represent faults proven by seismic survey; dashed lines represent faults inferred from gravimetric data.

I. Principal Characteristics of the Fault Zone

1. The fault trends northeast, the dip angle of the fault plane is steep at the top but lessens at the bottom, at and near the ground surface it is a high angled (60 to 80°) reverse fault, and approaching the deeper part it gradually diminishes to an (less than 20°) overthrust. For instance, the Lünan fault along seismic survey line 1001 has a fault plane dip angle of 77° decreasing steadily to less than 20° as it gets deeper.

2. The fault zone exists on a fairly large scale, and here and there it forms a "stacked tile" structure with nearly parallel reverse faults and overthrusts, and, from the shallow parts down to the deeper parts, gradually combines and is incorporated into them, forming plowshare-shaped faults. For example, the Lünan fault forms a stacked tile structure with three other parallel reverse faults near the surface, gradually combining into one fault as it becomes deeper, forming a plowshare fault.

3. The aspect of the strata in the vicinity of the hanging wall of the fault zone, or the strata enclosed in the fault is steep and precipitous or reversed, each stratum is successively overturned as it strikes south. For example, the northernmost part of the Xinan fault is a Proterozoic Era stratum, then to the south it becomes successively Jurassic system coal measures; Cretaceous system red beds; Tertiary system red beds and Quatenary system. Each stratum is separated by a reverse fault, constituting a fault zone; the dip angle of the strata is very steep, about 80°.

4. The faults have faulted through the principal oil generating rock system in the area, the Jurassic. For example, there are the Qianxi area of the western end of the Sainan fault and the Mahaiduoxiu Iqe area of the western end of the Lünan fault.

5. There are tar sands in the fault zone. On the south wing of the Mahai Gaxun structure, where the Lünan fault cuts through, there are, from east to west, Jurassic system and Paleocene and Eocene series of the Tertiary system. Among them are Middle Jurassic tar sands with an asphalt content of 7.82 percent; it is a gummy ashpalt with a fluorescence > 12.

6. Oil fields have been discovered and oil flows have been discovered along the fault zone. On the western extremity of the Lünan fault (this section of the fault has been proven with seismic data) the Iqe oil field has been discovered on the hanging wall, the oil-producing stratum is the bottom of the Upper Jurassic; in addition, in those wells that have been drilled on the Luyue He and Mahai Gaxun structures, oil flows are commonly seen at the same position, oil and gas have been seen in the lower Paleozoic dioriteporhyrite of well Duozhong 20. Again, oil flows are often seen in Jurassic system and Miocene series in several wells in the Qianxi area on the footwall of the Saima fault.

7. Along the headwall of the fault zone, carbon series marine facies limestone occurs intermittently. We may deduce that it should also occur on the footwall. Limestone may also be another potential oil source in the area.

8. There are elongated anticlines in the midst of the overthrust zone. For instance, in the Sainan overthrust, made up of the Sainan, Pingnan, Tuonan, and Quenan reverse faults which run nearly parallel and which is a series of successive nappes from northeast to southwest, there has been created a series of elongated anticlines striking northwest to southeast, such as the Tuonan anticline, the Quenan nose anticline, the Qianfu Number 2 anticline, etc.

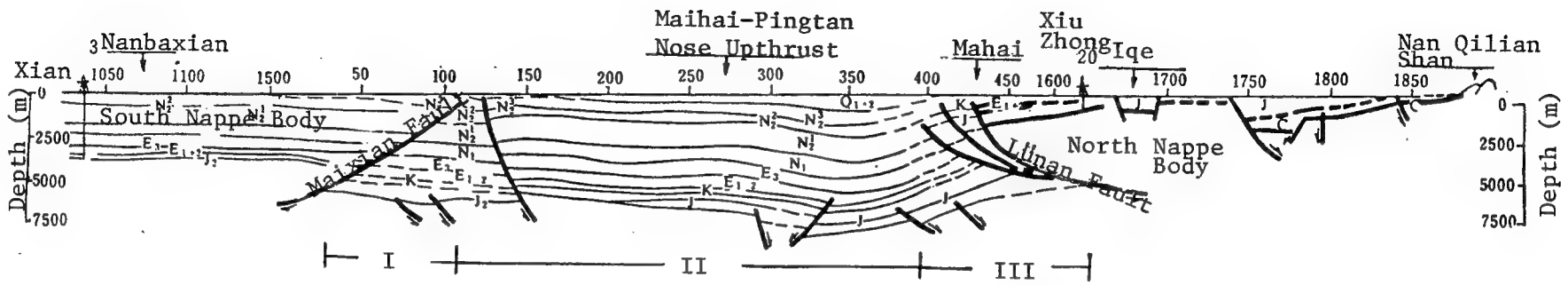
9. A gentle upthrust exists at the footwall of the overthrust zone. Part of the western extension of the Lünan fault, for instance, when subjected to seismic surveying proved that in the Mahai Pingtan area (south of Decunmahaihu) there exists a north plunging nose upthrust with an axis almost due north-south, cut off on the south by the Maxian fault, the span of the upthrust is 3,300m and it encloses an area of 176 square km of Lower Tertiary system.[1]

II. The Structural Characteristics of the Lüshan and Saishiteng Nappe Bodies

A. The Lüshan Nappe Body

1. General Structure

The Lünan fault is a bedrock fault discovered through gravimetric surveying, occurring on the south flank of Lüliang shan, trending northwest to southeast, dipping northeast. The western section (principally that part west of Lüliang shan, measuring about 25 km long) has been proven by reflected seismic survey data; the fault strikes 114°, dips 20°, plunges 51° in the shallow area but diminishes to less than 20° in deeper areas, with a narrow span at the top and a wider span near the bottom; it possesses the characteristics of overthrusts. This fault zone on the western part of Lüliang shan is a structure made up of three nearly parallel faults stacked like tiles. From north to south there are Lower Miocene, Middle Jurassic and Upper Jurassic systems, with each stratum separated by reverse faults (Figure 2).



I. South Nappe Zone
II. Nappe Gate Trap
III. North Nappe Zone

Figure 2. Geological and geophysical cross-section, seismic line 1001, Nanbaxian - Mahai - Pingtan - Iqe.

The Maxian fault is another bedrock fault pointed out by gravimetric surveying, it begins on its western end on the north wing of the Nanbaxian Shan structure, continuing east through the north wing of the Mahai structure to the western part of the Pingding Shan structure, measuring 55km long. According to reflected seismic survey data the sunken section has a length of about 35km. The fault strikes 82 to 115°, it dips 32° in shallow areas and less than 20° in deeper areas, it is a south plunging overthrust, faulted all the way to bedrock. The span of the fault is small near the top and greater near the bottom. At the bottom of the Pliocene[2] it is 850 meters, while at the top of the bedrock[3] the fault span is 2,000m, and the fault span becomes narrower approaching the two ends, east and west.

The Mahai-Pingtan depression: this is the eastern depression of the Saishiteng saddle; it is divided from it north to south by the Maxian fault, and it is bordered by the Lünan fault (western part) and Sainan fault (eastern part). In the east it reaches to the vicinity of the western portion of Lüliang shan and in the western border is about at the area of the Xiaoqiulin structure. The middle Cenozoic sedimentation in the depression reaches a greatest thickness of 10,000m, the Mesozoic sedimentation on the western edge near the Manao structure is about 300m deep, becoming gradually thicker to the east, until at the main body of the structure (the area between Decunmahaihu and Balongmahaihu, and east of there) it is 900 to 1,200 m thick. According to reflected seismic data, the Mesozoic occurrence is about 60 km long, east to west and about 25 km wide north to south, with an area of about 1,450 km^2.

2. Structural Characteristics

In this area there is the south striking nappe of the Lünan fault in the north, the north striking nappe of the Maxian fault in the south and between them there has been created a nappe depression, whose structure can be described in the following five points:

North nappe body: This is the Lünan fault's hanging wall, composed of Lower Paleozoic volcanic rock series including chlorite quartz schist, diorite porhyrite, etc. Above them are Tertiary system, Cretaceous system and Upper Jurassic system, constituting a series of anticlinal and synclinal structures.

North overthrust fold zone: This is the footwall of the Lüshan fault, made of Mesozoic strata, part of which is folded under Lower Paleozoic strata.

South nappe body: This is the headwall of the Maxian fault made of Quatenary, Tertiary, and Jurassic structures of the Nanbaxian anticline and the Mahai anticline (minus the Jurassic system) with a crystal basis of Proterozoic era composition.

South overthrust fold zone: This is the footwall of the Maxian fault, a part of the Mesozoic strata have been folded under Proterozoic strata.

Nappe depression: This is the Mahai-Pingtan depression, located between the Lünan fault and the Maxian fault, with sedimentation from the Jurassic period through the Quatenary, the Mesozoic sedimentation in the depression being several thousand meters thick, and located in the middle is the Mahai-Pingtan nose upthrust.

3. Differences Between Nappe Actions in the South and North

The Maxian fault occurred earler, manifestations of pre-Jurassic Yanshanian movement are very strong, to the point of causing a great deal of difference in the slip of the two sides of the fault and controlling the Mesozoic and higher strata. Sedimentation located on the Nanbaxian and Mahai structures of the headwall is fairly thin. The thickness of the Cenozoic and Jurassic systems in the Nanbaxian structure is about 4,628 m, the Middle Jurassic is 103.5 m thick (well Xian 3 hit bedrock at 3,638.5 m, finding Proterozoic chlorite schist and biotite chlorite schist, and that the Jurassic is not in conformity to the top). There are no Mesozoic sediments in the Mahai structure, but the Cenozoic sedimentation is 3,500 m thick (well Mashen 1 hit bedrock at 986 m finding Proterozoic granite gneiss, and that the Paleocene and Eocene series are not in conformity to its top). But the footwall has Middle Cenozoic sedimentation with a total thickness as much as 8,000 m, and in that Mesozoic sediments reaching 500 to 1,200 m.

The Lünan fault occurred relatively later than the Maxian fault, beginning in the first age of Xishanian action (on the Mahai Gaxun structure's western section the Jurassic system is seen on the earth's surface thrust over Paleocene and Eocene series), in later ages of intermittent action there was no evident controlling action of the sedimentation in the headwall and footwall. The Luyue He structure in the headwall has Miocene sedimentation to a thickness of 6,025 m, and Mesozoic sedimentation 1,290 m thick inside that; the footwall near the fault has Miocene sedimentation of an average thickness of about 6,000 m, thicker still in the center of the depression, with a greatest thickness of 10,000 m, the Mesozoic being 1,200 m.

B. The Saishiteng Shan Recumbent Fold Body

The principal occurrence of the Saishiteng shan nappe body is the south margin of the western part of Saishiteng shan, that is, the north part of the depression in the west part of the Saishiteng saddle. This overthrust zone is made up of four nearly parallel northwest to southeast striking, southeast dipping reverse faults or overthrusts, the Sainan, Pingnan, Tuonan, and Quenan (Figure 3). Its characteristics are as follows:

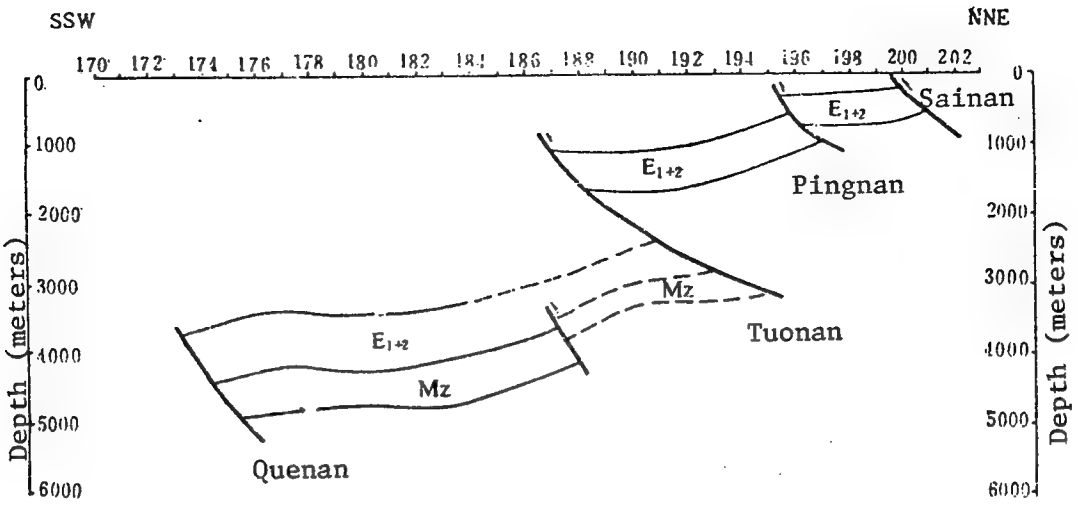


Figure 3. Cross-section along seismic line 200 (scale: horizontal axis is 2.5 times the vertical axis).

1. The plunge angle of the fault plane is steep (60 to 70°) in shallow areas leveling out gradually to 30 to 20° in deep areas.

2. The nappe on the headwall is a stacked tile structure, the four faults have been made into nappe structures one after the other from north to south, so that the bedrock drops deeper under each one from north to south, and the Mesozoic sedimentation becomes gradually thicker from north to south.

3. Anticlines have been created between every two faults due to elongation, so there are the Pingtai, Santai, Tuonan, and Qianfu Number 2 structures from north to south.

4. The fault span is narrow at the surface and becomes wider at deeper levels, all fault through to oil generating system (Middle Jurassic), for example the Sainan fault has a span of 1,800 m at the bottom plane of the Mesozoic,[4] while it is 2,400 m at the top plane of the bedrock; the Tuonan fault has a span of 1,800 m at the bottom plane of the Pliocene,[5] while at the plane of the bedrock it increases to 5,400 m.

5. The Sainan fault strikes northwest to north northwest, and dips northeast to east northeast. It has been shown by seismic surveying to be a line extending 20 to 42 km, seismic measurements have shown the part that extends to the northwest is broken in several places, so it may be that it

should continue further west, but where it reaches the vicinity of the Qianxi fault it may have been cut off by that fault, so its circumstances further westward are unknown.

6. In the Qianxi area of the footwall of the Sainan fault several wells have been drilled in Tertiary and Jurassic series, and all have found oil flows.

III. Characteristics of the Xinan Fault and Ainan Fault

The two faults are bedrock faults pointed out by surface geology and gravimetric measurements. They occur on the southern fringe of Xitieshan Aimunikeshan striking east perhaps as far as the vicinity of Xiariha, with a total length of about 250 km; they are reverse faults striking north northwest turning to northwest. The fault zone is made up of several nearly parallel reverse faults, going from old to new strata from north to south, they are successive nappe structures stacked like tiles, as in Figure 4. This fault has only been proven by seismic survey on the south margin of Xitieshan near the Dun-Ge Highway; the dip angle visible at the surface is 80°, but it is unclear what changes take place deeper down. There has been activity here on and off since the Yanshanian movement.

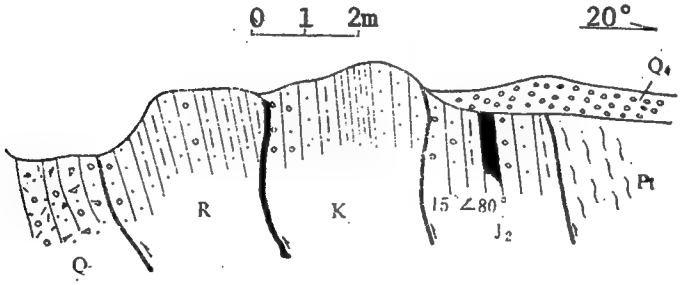


Figure 4. Sketch map of cross-section of Xinan Fault

IV. Conditions for Oil Generation and Accumulation in Overthrust Zones, and the Prospects for Finding Oil

A. Geochemical Characteristics of Oil Source Rocks

1. There is a fair amount of deviation in the geochemical indications of oil generation in the Mesozoic erathem of the northern margin of the Qaidam Basin, we will not discuss them here. The characteristics of the Mesozoic erathem (with attention to the Jurassic series), based on analysis of samples taken by Northwest University in 1981, is given in Table 1.

Cross-sec. / Position	Lenghu	Jielusu	Iqe	Dameigou	Delingha	Wanq Gaxun
K	1.88 (2) 0.42—3.33					
J_3^1				0.08 (1)		
J_2^7		1.82 (1)	1.78 (2) 1.47—2.09	2.09 (1)		4.25 (1)
J_2^6	2.02 (7) 0.51—4.84		0.84 (1)	0.31 (1)		
J_2^5	2.04 (7) 0.30—4.36		0.88 (3) 0.71—1.04	14.72 (1)		0.57 (1)
J_2^4	0.68 (6) 0.21—1.62		0.65 (1)	0.87 (1)	1.41 (1)	
J_2^3				0.18 (1)		
J_2^2				10.06 (1)		
J_2^1				5.46 (1)		
J_1^3				1.25 (1)		
J_1^2				0.12 (1)		
J_1^1				3.33 (1)		

Table 1. Average organic carbon content (C%) at each stratigraphic position in the northern fringe of the Qaidam Basin.
(Source: Tang Xiyuan [3282 6932 0337] et al., "Mesozoic and Cenozoic Structures in the Fault Block Zone on the North Margin of the Qaidam Basin, and Direction for Oil Prospecting There." The numbers in the table are respectively: average values, number of samples, numerical range. Following tables idem.)

Organic carbon content is fairly widespread through the Middle Jurassic system, it is mostly above medium levels, best at Lenghu and next best at Iqe; the seventh stratigraphic position has the most widespread content of organic carbon, position four, five and six are average, and of them the fifth and sixth positions in the Lenghu area reach the point of being good oil-generating indicators. See Table 1. Middle Jurassic trichloromethane asphalt "A" content meets or exceeds average in position four and above in the Lenghu area; position seven of Iqe approaches good oil generating indications, while four through six differ slightly; positions one, two, five and seven of Dameigou approach average; Wang Gaxun's fifth and seventh positions approach the level of good oil generating rock. In a regional comparison, Dameigou has the lowest content; from the point of view of a cross-section of the strata, position seven is a little better everywhere except Dameigou. See Table 2. For the overall hydrocarbon content, see Table 3.

Position \ Cross-sec.	Lenghu	Jielusu	Iqe	Dameigou	Delingha	Wang Gaxun
K	0.060 (2) 0.0050—0.1150					
J_3^1				0.0024 (1)		
J_2^7		0.0523 (1)	0.1283 (2) 0.0121—0.2445	0.0236 (1)		>0.1838 (1)
J_2^6	0.0842 (6) 0.0077—0.2050		0.0020 (1)	0.0025 (1)		
J_2^5	0.0564 (7) 0.0029—0.1109		0.0032 (3) 0.0024—0.0043	0.0420 (1)		>0.3319 (1)
J_2^4	0.0277 (6) 0.0034—0.0965		0.0020 (1)	0.0019 (1)	0.0155 (1)	
J_2^3				0.0022 (1)		
J_2^2				0.0827 (1)		
J_2^1				0.3425 (1)		
J_1^3				0.0016 (1)		
J_1^2				0.0025 (1)		
J_1^1				0.0063 (1)		

Table 2. Average values of trichloromethane extracts (A%) at each stratigraphic position in the northern fringe of the Qaidam Basin.

Position \ Cross-sec.	Lenghu	Jielusu	Iqe	Dameigou	Delingha	Wang Gaxun
K	308.5 (2) 40.3—720					
J_3^1						
J_2^7		93.3 (1)	152.2 (2) 33.5—270.9	36.0 (1)		>1104.0
J_2^6	270.7 (6) 31.6—864.0					
J_2^5	316.8 (6) 128.0—744.0		10.5 (1)	251.2 (1)		>1512.6
J_2^4	149.7 (3) 10.1—253.0				59.2 (1)	
J_2^3				4.1 (1)		
J_2^2						
J^1				904.9 (1)		
J_1^3						
J_1^2						
J_1^1				22.4 (1)		

Table 3. Average total hydrocarbons in each stratigraphic position in the northern margin of the Qaidam Basin.

According to data on the regular paraffins, the organic qualities of the Middle Jurassic system fall into the mixed category. When compared, positions four and five of the Legnhu area have a higher proportion of their organic material supplied by continental vegetable sources; samples from Wang Gaxun mainly had their origins with the lower orders of marine animal life. Generally, we see that organic matter is fairly abundant.

The degree of maturation of organic matter drops gradually from high to low as we proceed from west to east (Table 4). The degree of maturation is the greatest in position four and five of the Lenghu. The R_o value at position 4 is 1.08 to 1.35 percent, mostly falling into the peak phase of oil generation; the R_o value of position five is 0.8 to 1.15 percent, mostly within 1 percent, also falling into the peak oil generation phase; Iqe position five is less mature, position five and below at Dameigou have already matured, the R_o value is 0.77 to 1.08 percent, but to the east at Delingha it is less mature, and at Wang Gaxun it is still not mature. Position seven throughout the area has not yet matured. But the various samples collected from outcrops along the fringes of the basin, such as where the footwall of the reverse fault is buried fairly deeply, imply that there should be good oil-generating rock series.

Cross-sec. / Position	Lenghu	Jielusu	Iqe	Dameigou	Delingha	Wang Gaxun
J_2^7		0.85*	0.58	0.55—0.65		0.46
J_2^5	0.8—1.15		0.75	0.77	0.65	0.44
J_2^4	1.08—1.35			1.08		

Table 4. Reflection values (R_o %) in reflective bodies in positions 4, 5 and 7 in the Middle Jurassic system of the northern margin of the Qaidam Basin.

* The R_o value here is skewed too high for this area; perhaps it is due to organic matter from deeper sedimentation being mixed in.

2. Limestone series crop out intermittently along the overthrust zone on the northern margin of the Qaidam Basin. This is most developed in the Shihuigou-Oulongbuluke area, the cross section of Shihuigou measures 2,000 m thick, mainly limestones and sandy rock trypes and according to analysis of samples (see Table 5), organic carbons are in abundance; while the content of hydrocarbons and extracts of trichloromethane is low, this alone is not enough to say that organic materials are few in the primary source, because the organic matter is at or near the maturation phase, the cleavage is very deep, and those liquid hydrocarbons which have been generated have turned into low molecular weight products, exceeding the scope of present methods of investigation, but creating the false impression of little abundance of organic matter. There is not much continental vegetative or animal matter in the make up of the organic matter, and this is favorable for oil generation. From the point of view of degree of maturation, Shihuigou has approached maturation, Wang Gaxun is just at the maturation phase, exhibiting the geochemical conditions for the generation of liquid hydrocarbons.

No.	Rock Series	Age	C(%)	"A" (%)	Hydro-carbons (ppm)	R_I*	R_o(%)	Cross-section
1		C_1h_2	0.04	0.0022	11.9	1.41	1	Shihuigou
2		C_1h_5	0.08	0.0020	1	1	1	
3		C_1h_8	0.05	0.0022	1	1	1	
4		C_1h_8	0.04	0.0019	11.1	1.82	1	
5		C_1h_{11}	0.19	0.0033	15.2	1.27	1.55	
6		C_2h_{20}	0.97	0.0027	1	1	1	
7		C_2h_{23}	0.15	0.0053	21.3	1.33	0.95 1.25	
8		C_3z_{26}	0.61	0.0040	15.1	1.14	1.29	
9		C_3z_{30}	0.02	0.0029	1	1	1	
10		C_2	1.35	0.0177	0.669	0.73	1.13	Wang Gaxun

Table 5. Analysis of limestone series rock samples.

$$* \; R_I = \frac{CPI_{22-30}}{CPI_{14-22}}$$

B. Conditions of the Reservoir Beds

There are two reservoir beds in the Mesozoic erathem of the northern fringe of the Qaidam Basin. One is position six of the Middle Jurassic in the Lenghu area, the existence of that reservoir bed has already been discovered in the Lenghu Number 3 oil field; the other is on the bottom of the Upper Jurassic of the Iqe area, and its existence has been discovered in the Iqe West oil field. Besides these, tar sands appear in the Upper and Middle Jurassic system of the earth's surface over the entire Iqe area. The limestone series reservoir beds have not been studied in the past, and although they exhibit the conditions for oil generation, due to the conditions for preservation in later stages, they are certainly not ideal, and no shows of oil or gas have been found in them to date. The study of oil generation and accumulation in the limestone series has now just begun, data is lacking, and it will not be discussed now. The Triassic is not lacking for good reservoir beds, as has been proven with the discoveries in the Oligocene at Lenghu Number 4 oil field and in the Upper Miocene and Lower Pliocene at Lenghu Number 5 oil filed, the Oligocene at the Mahai gas field, etc. Between them are secondary reservoirs.

The typology of the porosity in the Middle Jurassic and the bottom Upper Jurassic reservoir beds was studied by Zhu Zongqi [4376 4920 4388] et al. of Northwest University in 1981, who recognized three types of porosity (intragranular, intergranular and intercrystalline) and six types of porous systems (intercrystalline porous system, intergranular porous system, intergranular porous system, inter- and intragranular porous system, intergranular and intercrystalline porous system and mixed porous system). Although these two reservoir beds change frequently along the plane or the cross-section, neither of them lacks a high degree of porosity, or caorse throating, making for ideal reservoir sections, if only there were an adequate oil source they would form industrial oil pools.

C. Prospects for Finding Oil

1. There is already data to confirm that overthrusts are conduits for the migration of oil. For example, in the overthrust zone on the south wing of the eastern section of the Mahaiduxiugou structure on the western section of Lüshan, the sandy conglomerate of position five of the Middle Jurassic is clearly immersed in oil, fluorescent analysis has shown the asphalt content to approach 7.28 percent, with gummy substances prevalent. There are tar sands 2 meters thick, which continue intermittently for 4.2 km, in the Paleocene and Eocene of the south wing of the structure, illustrating the existence of an oil source in the footwall of the fault zone. If only a main fault were to fault through to the oil generating position, then it would make a conduit for oil and gas migration, and if that were to run into a favorable trapping environment, then an oil and gas pool would be formed. To take another example, tar sands appear in many places in the bottom of the Upper Jurassic of the Luyue He structure, the western part of the Iqe oil field would allow us to infer that the gas and oil generated in the Middle Jurassic system of the footwall of the fault should migrate upward along the fault and then migrate laterally once reaching the headwall, or else migrate along the branched faults in the north nappe body. Perhaps the Oligocene gas stratum of the Mahai gas field on the headwall of the Maxian fault is a result of this lateral migration or migration along the branched faults of the south nappe body.

2. Important Middle Jurassic oil generating rock series have already been proven on the north margin of the Qaidam basin. Position six of that system and the bottom of the Upper Jurassic are both oil reservoir strata. Analysis of the above data makes it clear that oil generating conditions are fairly good in position five and below of the Middle Jurassic system of this area, with the highest level of maturation in the Lenghu area, and a gradual decrease to the east; position seven is black colored paper shale over 100 m thick, no matured section has been found in previous cross-section, but at the relatively deep position of the footwall of the overthrust, it could be an ideal oil-generating rock series.

According to seismic surveys the Saishiteng saddle to the south of the overthrust running from Saishitengshan to the southern edge of Lüliangshan is

divided into two secondary depressions, east and west, the western portion, the Saishiteng depression, begins at the Lenghu Number 3 structure in the west and reaches the eastern part of the Xiaoqiulin structure in the east, with its southern border near the Lenghu structure zone and its northern border on the southern margin of Saishitengshan, it is a Mesozoic occurrence 2,150 km^2 in size. The sedimentation north of the Tuonan fault zone is fairly thick (200-500 m), and it becomes thicker (from 400 to 1,000 m) to the south, with a greatest thickness of 1,100 to 1,300 m. The eastern section, the Mahai-Pingtan depression, has a Mesozoic occurrence like the one just described, and it too is thin in the west and thicker in the east.

Combining the special characteristics of the nappe bodies of the Lünan overthrust and the Sainan overthrust from the viewpoint of the conditions of Mesozoic occurrence, the areas in which oil may be found are:

Mahai-Pingtan depression. Mesozoic sedimentation reaches 900-1,200 m in thickness here, implying that there should be an oil generating rock series at position seven of the Middle Jurassic or below, that oil generating conditions are quite good, that the degree of maturation should be fairly good, that the overthrust parts of the nappe bodies on the north and south are both fairly narrow, there are definite oil accumulation conditions present, and in addition to Mahai-Pingtan nose anticline, striking nearly north to south and plunging north, its south face cut off by the Maxian fault, has been discovered in the depression. That structure shows basically the same form from the shallowest to the deepest parts, with a greater trapping area down deep; seismic reflection shows a bottom Pliocene trapping area of 140 km^2, the span of the structure being 1,400 m; while the bottom of the Tertiary has a trapping area of 176 km^2, the span of the structure being 3,300 m. The latter is buried to depths no less than 4,100 m. So there is hope for finding primary oil generating pools in the Mesozoic and secondary generating pools in the Cenozoic along the upthrust zone (the Mahai-Pingtan nose structure) on the front edge of the nappe bodies and on the overthrust portions of the Lünan and Maxian overthrusts. Chances of finding oil pools similar in type to the Iqe oil field along the Lünan fault (western part) should not be overlooked either.

Front edge of the Tuonan fault footwall nappe body. Located in the deepest depression of the Saishiteng depression, with Mesozoic sedimentation about 1,000 m thick, this area also has a row of hidden structures, such as the Qianfu [hidden] Number 2 structure, the Quedong hidden nose anticline, etc. The axis of the former strikes northwest, trapping is excellent, seismic study shows the bottom of the Tertiary buried at 4,500 m, with a total trapping area of 14 km^2, a closure of 300 m; the axis of the latter is northeast, plunging south, its north flank is cut off by the Tuonan fault, and it also manifests excellent trapping conditions, seismic study shows its bottom Tertiary to be buried at 4,300 m, trapping area to be 30 km^2, and closure to be 600 m. All the exploration wells drilled in the Qianxi area nearby have reached the Middle Jurassic directly through the Paleocene and

Eocene of the Triassic, demonstrating that this area lacks a Cretaceous or Upper Jurassic, which decreases the depth required to drill to the primary oil generating pools of the Middle Jurassic. In addition, there are planes of unconformity between the Jurassic and Tertiary and these could form unconformity pools. At the same time, there should be concealed oil pools in faults on the footwall of the Quenan fault.

Footwall of the Sainan fault. The nappe zone south of the Heishiqiu anticline is fairly narrow, with unconformities between the Paleocene and Eocene and the top of the Middle Jurassic, it may be hoped that unconformity pools will be found, and if there is good trapping, Mesozoic primary source pools may be found.

Footwalls from the Sainan to the Lünan to the Xinan to the Ainan faults. Limestone series calcareous rocks crop out on the headwalls of these faults, with real possibilities for oil generation. Thus, the oil and gas prospects for the limestone series of the footwall of this fault zone should not be overlooked.

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FOOTNOTES

1. This is the T_R seismic reflecting stratum.

2. Seismic reflecting stratum T_2'.

3. Seismic reflecting stratum T_6.

4. Referred to as T_3.

5. Referred to as T_2.

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CSO: 4013/198

STRUCTURAL TRAPS IN NORTHWEST SICHUAN AND A PRELIMINARY ANALYSIS OF ACCUMULATION OF HYDROCARBONS IN THEM

Beijing SHIYOU KANTAN YU KAIFA [PETROLEUM EXPLORATION AND DEVELOPMENT] in Chinese No 6, 1983 pp 13-16, 22

[Article by Li Baoshi [2621 1405 4258] of the First Petroleum Exploration Department, Research Institute, Ministry of Geology and Mineral Resources]

[Excerpts] Abstract

The types of local structures in northwest Sichuan are mainly anticline and nose formed by a sealing fault cutting an anticline. These structures are characterized by their directional orientation, migration and torsional features. The geological features of these structures are the controlling factors in the accumulation of oil and gas to form commercial reservoirs.

A number of local structures are distributed in the northwest part of the Sichuan basin. In terms of formation, some structures are formed early in geological time and others are epigenetic. In terms of morphology, some are hidden beneath the earth's surface and some are exposed above ground. A study of the characteristics of these structures is useful to the exploration and development of petroleum.

I. Directional Orientation of the Structures

A bird's-eye view of this region reveals a distinct directionality of the three-dimensional profile. The overall structure is based on the Longmenshan structure zone and the Longquanshan structure zone, most of the other local structures are parallel or almost parallel to these two. The layout of the local structure shows a strong directionality in favor of the northeast quadrant, that is, almost all the local structures are oriented in the east by northeast to the north by northeast direction. Structures oriented in the northeast direction are numerous, widely distributed and with outstanding appearance. They are dominating structures of the region and determine the geomorphology of the entire region.

II. The Torsional Nature of the Structure

An intrinsic connection exists between the formation and development of most of the local structures in the region. Besides the similarity in spatial layout

and orientation, most of the local structures have various degrees of torsion. This torsion manifests itself mainly in the sequential and combinational arrangement of the local structures, in the systematic bending of the axis and in the mechanical properties of the fracture planes.

Due to differences in boundary conditions and inhomogeneities in the rock property, the torsional nature and the structural form of the local structures in the region also vary, most being straight and very few spiral. The structures are mostly η -shaped, followed by the λ-shaped structures and a few broom-shaped structures.

1. η -shaped structures

These torsional structures are very common in this region, especially in the southern part of the region west of Longquanshan. Furthermore, the η -shaped structures not only show up as surface structures but also as subsurface structures without surface indications. Such underlying η-shaped structures are visible on structural maps constructed from earthquake reflection interfaces.

2. λ -shaped structures

It is well known that the λ-shaped structure consists of a trunk and a branch. It is usually a combination of a main fracture and a branching fracture or a local structure. The branch fracture and the local structure may be present simultaneously. They may appear on one side of the main fracture or on both sides of the main fracture and their magnitudes also vary.

Here, we are mainly interested in those λ -shaped structures that are related to the local structures in this region. Many examples can be found for this type of torsional structure both on the surface and underground.

For example, the main fracture of the Majianian λ -structure is the great Xiangshui fracture running parallel to the Longmenshan fold-fault zone. The mechanical nature of the fracture is mainly compressional, with a counterclockwise torsion. The fracture runs in a northeast direction and tilts toward the northwest; the Majianian nose anticline is a branching structure of the fracture.

Subsurface λ -structures can be identified on the earthquake reflection surface map. In this region we have λ-structures at Lueping and Wenxingchang in Anxian County and at Mianzhu.

We now describe briefly the λ -structure at Lueping in Anxian county. The trunk structure runs in a north-by-northeast direction and tilts in an east-by-northeast direction. It is mainly compressional, with some torsion. The branching structure is a nose anticline. The apex of the acute angle between the anticline and the main fracture points toward the ascending disc of the main fracture and the orientation is still north by northeast.

All the mechanical properties of the structural surfaces of the λ-shaped structures point to a mode of stress that is a straight torsion running to the south in the western part of the region and running toward the north in the eastern part of the region. The characteristics of the stress field of the λ-structure are consistent with that of the η-shaped structure. It is therefore clear that both types of structure are products of the overall structural stress field of the region and can be explained by the same mechanical formation model.

3. Broom-shaped structures

In addition to the straight torsional structures in this region, there are also a few spiral torsional structures. Among the large ones is the Mianyang broom structure located in the Mianyang and Zitong region and consists of a series of anticlines panning out like an arc. From north to south, the major anticlines are the Wenxingchang subsurface anticline, the Laoguanmiao anticline and the Fushunchang anticline. The layout is such that it converges toward the northwest and opens up toward the southeast and has the shape of a broom bulging toward the northeast.

In addition to the Mianyang broom, there are also a few spiral torsional structures of smaller magnitude and they will not be discussed here.

III. Migration of the Structures

The migration nature is common to the structures in this region. It is manifested mainly in the geological phenomena associated with the coupled motion of the local structures and the regional structures. In the development process of the basin, regional structures associated with the local structures migrated in the northwest direction from the peripheral to the interior of the basin and resulted in the systematic and sequential changes.

The local structures, as a result of the migration, show a regular sequence of old structures to new structures as one moves from the edge to the middle of the basin. Local structures of different age are distributed along the edge of the basin in a belt running northeast.

The local structure, closest to the edge of the basin, is the Indo-China middle epoch local structure zone, the oldest in the region. Because of its early formation, it is repeatedly disturbed and damaged by the subsequent geological formations and movements and the only reamining structure is in the Tianjingshan area. It includes such local structures as the anticlines at Kuangshanliang, Tianba, and Tianjingshan and the inverted anticline at Shuigentou.

Moving toward the interior of the basin, the late Indo-China local structure zone forms a long, narrow strip oriented in a northeast direction along the foothills of Longmenshan. The structure zone includes local structures, from north to south, at Daoliuhe, Haitangpu, Zhongba, Anxian, Mianzhu, Yazihe, and Wuzhongshan. Most of the Indo-China late epoch local structure is burried underground and covered by late formed local structures of the Yanshan-Xishan period. Moving further into the interior of the basin, the structure makes a transition into the relatively recent formations of the Yanshan-Xishan period.

The migration phenomenon from the edge of the basin to the interior of the basin also manifests itself in the magnitude of the fold and in the fracture relationship. Local structures near the peripheral of the basin are often long, narrow and dense and the angles of inclination of the two wings are steep. Moving to the middle of the basin, the local structures become increasingly rounded and gradual.

In the direction of migration, there exists the following relationship between fractures and local structures: local structures along the peripheral of the basin are dominated by higher order large fractures accompanied by smaller fractures of the same order or of lower orders parallel to the axis. Toward the interior of the basin, not only the higher order large fractures become extinct, the number of the smaller fractures of the same order or of lower orders parallel to the structural axis also decreases gradually.

IV. Oil and Gas Content of the Local Structures

Since the Indo-China middle epoch ancient structural zone of this region is situated higher on the edge of the basin, some of the strata are exposed. We shall not discuss the oil and gas content of such exposed strata. In the space below, we will discuss the oil and gas content of the structure zones of the Indo-China late epoch and the Yanshan-Xishan period.

1. Since many of the local structures in this region are situated in or near the Western Sichuan Late Tnassic oil-bearing depression, the traps of the local structures combine with the nearby oil reservoir and provide favorable conditions for oil and gas.

The local structures formed during the Late Indo-China period have the distinct advantages of spatial proximity to the oil zone and the temporal proximity to the oil formation period. Such favorable conditions lead to the migration and accumulation of oil before the degradation of the porosity and osmosity of the strata. For example, above ground, the Zhongba anticline is a nose pointed to the northeast and the anticline trap is located below the topographic unconformity surface at the bottom of the Baitainba formation of the Jurassic system. This indicates that the anticline was formed during the Indo-China late epoch period. The area of the principal gas producing layer of the Zhongba structure, the Xujiahe formation 2d member structure, is three times the trapping area of the current 2d member. The gas reserve of this structure is therefore determined mainly by the ancient structure of the Late Indo-China period and not by the present structure.

In addition, the local structures in this region are mostly parallel or almost parallel to the Longmenshan fold-fault zone at the edge of the basin. This layout favors the retention of oil and gas. The oil and gas bearing layers of the basin are at the raised edge of the basin and often exposed above the earth surface and become water supply channels for the interior of the basin. However, since the local structures are often parallel or almost parallel to the raised edge of the basin and separated from it by predominantly compressional obsequent fault and dense trough bend, the active hydrodynamic conditions of these faults and trough bends have a sealing effect and help the trapping of oil and gas.

2. The formation mechanism of the local structures in this region is mostly related to the torsional motion. The series of bands of local structures of different form and magnitude were formed under the action of regional straight torsion and regional spiral torsion. Their formation provided trapped spaces for the accumulation of oil and gas and the torsional formation mechanism helped to drive the oil and gas and to create cracks.

In terms of driving the oil and gas by ground stress, the torsional motion is ideal. The stress field of the torsional motion is a shear stress which covers a large area and a wide range of directions. Under the action of the stress, the oil and gas are driven by the stress and accumulated by the stress relief process. The oil bearing layer and the oil reserve structure are connected by ground stress and the diffuse oil and gas are driven, transported and accumulated.

Experience shows that cracks in the structure are not only channels for oil and gas transport but are also accumulation and storage spaces for oil and gas. For the poor storage conditions in the region, the benefits of cracks cannot be overestimated. Torsion stress helps the formation of cracks. Based on the experimental evidence of material mechanics, a pure compressional stress is unlikely to produce cracks, especially tensile cracks. Only the torsional stress consisting of a compressional stress and a couple will facilitate the formation of a large number of cracks. The torsional motion not only promotes the growth of lateral tensile cracks but also favors the transformation of the radial cracks and connects the two groups of horizontal and vertical cracks to form a well-connected crack system.

The controlling effect of the cracks in the local structures in the basin has been positively verified in the drilling operation. The gas field of the Xujiahe formation of the Zhongba structure is of the porosity-crack type and the gas yield per well is directly affected by the cracks. Leaking and flooding were encountered in the "Xu-4" drilling of the Yuquan and the Xiaoquan structures. Automorphic and semi-automorphic calcite and quartz crystals were found in the rock chips, indicating the growth of cracks. Test results showed a certain amount of gas yield.

Conclusions

The dominating structures of the local structures in the West Sichuan region are the various forms of torsional structures formed under the action of a counterclockwise torsion stress and the accompanying spiral torsion stress. The various types of local structures control the migration and accumulation of oil and gas in the basin and lead to a rich oil and gas reserve in the northwest part of the basin. A thorough understanding of the characteristics, growth, distribution, and relationship to oil and gas formation of the various torsional structures in the area is extremely beneficial to the exploration and development of oil and gas.

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9698
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BRIEFS

LIAOHE SETS ANOTHER RECORD--Liaoning Province's Liaohe oilfield, the fourth largest in the country, has made new achievements in production and construction. In early August, the daily output of crude oil reached 21,000 tons, setting a record. In the first 7 months of this year, the output of crude oil was 25 percent higher than that for the same period of 1983. [Summary] [Shenyang LIAONING RIBAO in Chinese 7 Aug 84 p 1 SK]

TRANSMISSION LINE ACROSS HUANG HE--China's first gas transmission pipeline across the Huang He was recently built connecting Puyang County in Henan Province and Dongming County in Shandong Province. The pipeline will transmit gas from the Zhongyuan oil fields to the Kaifeng Chemical Fertilizer Plant. The line has a total length of 148 kilometers and the section that crosses the river is 1000 meters long. The pipeline has the capacity to transmit 115 million cubic meters of gas a year. [Excerpt] [Shenyang LIAONING RIBAO in Chinese 20 Jun 84 p 1]

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NUCLEAR POWER

TALKS ON DAYA BAY REACTOR JOINT VENTURE CONTINUE

HK130238 Hong Kong SOUTH CHINA MORNING POST in English 13 Aug 84 p 11

[Article by Ophelia Suen]

[Excerpts] Momentum is gathering in Shenzhen to ensure the Daya Bay nuclear joint venture company contract is ready for signing later this year.

The contract will be signed between the Guangdong Nuclear Investment Company (GNIC) and the Hong Kong Nuclear Investment Company (HKNIC).

And there is an apparent keenness to secure three other equipment and civil work design contracts with Framatome, Britain's General Electric Company (GEC) and Electricite de France.

At least 10 working groups comprising more than 100 representatives from the parties involved have been holding intense negotiations in the 13-storey nuclear power office building in Shenzhen.

According to the vice minister of China's Ministry of Water Resources and Electric Power, Mr Peng Shilu, the draft contract for the joint venture company has been completed and is being reviewed by both parties.

Mr Peng, who is in charge of the project for China, told the SCM [SOUTH CHINA MORNING POST] in a recent interview in Shenzhen that he did not expect any major amendments after the review.

He reckoned that the actual signing of the contract--by a top-level GNIC representative and Lord Kadorrie, chairman of China Light and Power--could be expected between October and the end of the year.

He was emphatic that the project had not run into any obstacles, saying that negotiations on all the contracts have gone "very smoothly."

He dismissed as rumors Hong Kong news reports that China Light and submitted a new proposal thus delaying the setting up of the joint venture company.

Mr Peng said that there was unlikely to be any change in the basic provisions proposed earlier, and that Hong Kong consumers were still expected to buy 70 percent of the electricity generated by the Daya Bay nuclear plant in the 1990s.

As for the cost of the power, Mr Peng maintained that it would be cheaper than coal-fired power, that is less than seven U.S. cents per unit compared to between 7.5 and 8.5 cents.

While the Hong Kong Government has estimated that the project will cost some $36 billion, Mr Peng has come out with estimates of between $28.8 billion and $21 billion.

Meanwhile, it was understood that China Light remained the lone backer for HKNIC and had acted as the sole dealer in its representation on the joint venture with China.

According to Mr Peng, in addition to the joint venture company contract, three others are also to be finalized hopefully also in October, and not later than the end of the year.

They are: An equipment contract for the nuclear island including the twin 900 megawatt reactors, to be signed with Framatome.

An equipment contract for the conventional island, notably the generator and the steam turbine, to be signed with Britain's GEC.

The contract on civil work design, to be signed with Electricite de France.

Mr Peng said representatives from all three companies had been discussing the scope of supply with GNIC and China Light.

Pricing, he said, will be tackled soon, adding: "We have to budget accordingly."

Speculation is rife that China might strive to [win] a better price by ordering a larger package, with additional nuclear projects in other parts of the country, notably Shanghai.

However, Me Peng refused to comment on this.

He said the order list for the Daya Bay project alone "runs into hundreds of thousands of items and just could not be put down simply."

It includes the reactor, pressure vessel, reactor vessel, the fuel element, reactor core, control rods, steam generator, and pipes.

He said the reactor vessel is likely to come in separate pieces: the vessel itself, the lid, the core, and the fuel element.

"These would then be assembled by Chinese workers at the site (in Daya Bay) supervised by the Framatome staff," he said.

He added that there would be "no problem as far as safety was concerned.

The Daya Bay nuclear project is one of the largest, if not the largest, investments ever in Guangdong Province.
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SUPPLEMENTAL SOURCES

BIOGAS MAY SERVE 10 MILLION HOUSEHOLDS BY 1990

OW151131 Beijing XINHUA in English 1030 GMT 15 Aug 84

[Text] Beijing, 15 Aug (XINHUA)--Biogas will become more widespread as a substitute for coal and firewood in China's countryside as well as in small towns in the years to come, according to a report by the Ministry of Agriculture, Animal Husbandry and Fisheries.

Biogas, also known as methane, is produced by fermenting such wastes as manure, stubble, and other organic materials in a specially constructed pit. China has been stressing the development of biogas so as to help solve the energy shortage.

The report, which was transmitted by the State Council recently to departments concerned throughout the country, proposes to bring biogas to 10 million rural households by the year 1990. It also suggests improved ways to construct and manage biogas-production facilities.

For this purpose, each locality should work out its own plan to combine housing construction and environmental protection with the development of biogas, and strengthen scientific research on new technology and new materials for biogas pits, the report continues.

It recommends that special classes on the subject of biogas should be held in colleges and secondary technical schools, where conditions permit.

A total of 2.38 million biogas-generating pits were built in China's rural areas in the past 4 years and standards and rules for their construction have been formulated, the report says.

Offices specializing in propagating the use of biogas have been established in 25 of the 29 provinces, autonomous regions and municipalities on China's mainland, and training courses of various kinds have been held, the report says.

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SUPPLEMENTAL SOURCES

EXPERTS DESIGNATE PINGTAN ISLAND AS IDEAL WIND, TIDAL POWER DEVELOPMENT SITE

Fuzhou FUJIAN RIBAO in Chinese 6 Aug 84 p 1

[Text] Experts from the State Scientific and Technological Commission, the National Bureau of Oceanography, energy research societies, the Ministry of Water Resources and Electric Power, the Ministry of Machine Building Industry, and concerned departments of the two provinces of Fujian and Zhejiang have formed the National New Energy Resources Island Study Group and recently conducted a detailed study on the ocean and wind power resources of Pingtan Island. They determined that by using its abundant new energy resources, Pingtan County could become an island for development and utilization of new sources of energy.

Pingtan Island is located in the Strait of Taiwan and has 280 days of winds of level 4 or above a year for an average wind velocity of 8.4 meters a second--an ideal place to erect wind-powered generators. Today, the island has the largest such unit in the country, a 55-kilowatt station already in experimental use. The coastline of Pingtan Island is 305 kilometers long and has one of the biggest tide differentials in the nation, an average of 4.24 meters. The entire island could be developed as a tidal power station with an installed capacity of more than 270,000 kilowatts generating as much as 700 million kilowatt-hours of electricity a year. The county's numerous coastal pools and coves could be developed for wave and tidal power.

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CONSERVATION

IMPROVING ECONOMIC RESULTS THROUGH ENERGY CONSERVATION

Beijing NENG YUAN [JOURNAL OF ENERGY] in Chinese No 3, 25 Jun 84 pp 6-8

[Article by Wang Xianglin [3769 4161 2651]: "Saving Energy Is an Important Way To Enhance Economic Results"]

[Text] In recent years, many provinces, cities, and enterprises in China have fully realized the strategic significance of energy conservation in China's national economic development and in improving the economic efficiency.

In some energy shortage areas in particular, pronounced results have been obtained in energy conservation. From 1979 to 1983 China's energy production averaged an annual growth rate of 1.9 percent whereas the gross value of production in industry and agriculture averaged an annual growth rate of 7.3 percent. This is the result of a major effort in energy conservation.

I. Energy Conservation and Economic Efficiency

The low rate of energy utilization in China is due to the following reasons:

1. Poor scientific management of energy resources

Although the energy conservation effort has been going on for many years, a number of enterprises still have not linked conservation to economic efficiency. Some people think that China produces great amounts of coal and oil and the cost of energy is not a problem. In Wuhan there are 62 enterprises each consuming more than 10,000 tons of coal per year, 55 of them have established conservation systems and two-thirds of these are effective. In one city there were 18 enterprises that each consumed more than 10,000 tons of coal in 1983 buy 7 of them were in an uncontrolled situation. Out of the 18 enterprises only 12 were equipped with water meters and only 6 had steam meters. A number of the 10,000-ton energy consuming businesses did not quantify their water and steam usage. In another city, only 22 out of 50 enterprises that consumed 5,000 tons of coal or more per year have established quotas for coal, electricity, water, and steam consumption, and only 7 adhered to the quota rigorously. Under such conditions there was no scientific management and there was no possibility for an improved energy utilization rate.

2. Production techniques are in urgent need of improvement

Today there are still a number of enterprises using outdated production methods and wasting a lot of energy. Take the steel rolling in the metallurgical industry as an example, foreign countries have achieved 50 percent of continuous casting and continuous rolling whereas China has only 0.7 percent or so. This low percentage not only leads to waste of energy but also increases the transportation load. If the continuous casting and rolling rate in China's steel industry could be increased to 50 percent by the end of this century, it would increase the steel production by 3 million tons and save 3 million tons of standard coal. The energy consumption by the chemical industry is directly related to the type of catalyst used. At Wujin Chemical Plant in Shanghai, the production of methyl alcohol was increased 20 percent, the energy utilization rate was improved 31 percent and the energy consumption was reduced 20 percent by using copper catalysts instead of zinc catalysts. The production of cement still uses 1930 and 1940 technology. By switching from a wet production method to a new dry production method outside the kiln, the Benxi Cement Plant reduced energy consumption per kilogram from 1,400 kilocalories to 800 kilocalories, such a large reduction is difficult to achieve by merely modifying the kiln. Most of China's large and medium cement plants use the wet method, the energy consumption may be reduced by 5 percent or so if they switch to the dry outside-the-kiln dissociation method.

3. Equipment Is Backward

China now produces 2.8 million electro-mechanical products, 60 percent of them are technologically obsolete and must be phased out or modernized. Such outdated equipment consumes a great amount of energy: they consume 90 percent of China's gasoline production, 40 percent of the diesel fuel, 33 percent of the coal, and 50 percent of the electricity based on a survey of 12 categories of electro-mechanical equipment including industrial boilers, pumps, blowers, small AC generators, compressors, automobiles, tractors, internal combustion engines, medium and small transformers, oxygen generators, industrial electric furnaces, and welding machines. Today, medium- and low-voltage electric generators of 50,000 kW or less in capacity make up 27.5 percent of China's total thermal electric generators. They consume 500 grams of coal per kilowatt-hour, which is tens of grams higher than the national average and more than 100 grams higher the consumption in industrially developed nations. Most of these medium and low voltage generators have been in use for more than 20-30 years. The key to a reduced coal consumption in China's power industry is the phasing out of this obsolete equipment. A major reason for the high energy consumption in China's chemical industry is the low quality of the old equipments. The chemical enterprises in Shanghai produces one-sixth to one-seventh of China's gross value of production in chemical industry and generates one-fourth of the profits, and yet many of the equipments are still of the 1930-1940 vintage and very energy extensive. The old ethylene production facility at the Gaoqiao Chemical Plant consumes as much as 1,740 kWh of electricity for every ton of ethylene produced, which is about 20 times the energy consumption of 80-90 kWh at the Jinshan General Chemical Plant. It is therefore clear that there is ample room for conservation in China's industry and our task today is to systematically and methodically improve the equipments and bring down the energy consumption by a large degree.

China is fully capable of carrying out a major conservation effort. For example, in the 3 years from 1979 to 1981, Zhejiang Province conserved energy and increased its industrial and agricultural value of production by an average of 1 percent while increasing its energy consumption by only 0.39 percent. From 1979 to 1981, the industrial value of production in Hubei Province went up an average of 1 percent but the energy consumption went up only 0.34 percent. Therefore, the overall economic efficiency can be improved as long as we actively engage in conservation and continue to improve the utilization rate of the energy resources.

II. Conservation and Economic Management

Judging from the conservation experience of many industrically developed countries, energy conservation reflects a country's general economic management standard and better economic efficiency can be achieved only by an overall strengthening of the scientific management of the energy resources.

In China's production costs, energy accounts for 70 percent in the power industry, 68 percent in the chemical fertilizer industry, 54 percent in the cement industry, and 34 percent in the glass industry. In Shanghai's industries and enterprises, the energy and raw material costs account for 84 percent of the product cost, a 1 percent reduction would increase the profit by 250 million yuan.

From a macroscopic point of view, an improvement in the energy utilization rate requires efforts in the mining, transporting, processing, converting and utilizing the energy resources to reduce energy consumption and boost production. From a microscopic point of view, all the energy consuming departments must reduce wastes and cut losses in each step of the energy usage and use the energy rational to reduce the production costs continuously.

For the current situation in China, the foremost task in energy conservation is measurement. Accurate measurement and complete data are indispensable if an enterprise is to grasp the energy consumption situation. In recent years many areas in China have installed electric, water and gas meters and charged the usage according to the quantity used and achieved good economic results. At the Panzhihua Steel Company in Sichuan, the amount of metered energy usage used to be less than 40 percent. After stressing quantified energy usage, 98 percent of the energy used was metered and the energy consumption per ton of steel dropped 33.6 percent and 4 million yuan were saved in the 4-year conservation effort, equivalent to 8 times the investment of 5 million yuan installation cost. Sichuan Province spent more than 1 year's time installing meters and by the end of 1982, 95 percent of the electricity and gas were metered and 70 percent of the water usage were metered. In 1 year, Sichuan saved 110 million kWh of electricity, 120 million cubic meter of natural gas, and 70 million tons of water, equivalent to a total of 42.5 million yuan. In Nanjing, only 72 million yuan were spent on meter installation to cover 99.5 percent of the electricity users and 25 million kWh of electricity were saved in one year. Statistics of the Yunnan Refinery showed that before meter installation each household consumed 36 kWh of electricity and the figure dropped down to 12 kWh after metering.

Establishing a rigorous quota is an important step in the scientific management of the energy resources. Quota is a measure in the economic accounting and it is also an evaluation standard for conservation. Without a rigorous quota on energy consumption, conservation would not be possible. Today, provinces and cities in China are strengthening their quota management and improving their conservation reward system to increase the utilization rate of energy. The main efforts in Shanghai Municipality are across the board accounting, statistical analysis, quota evaluation and rewarding conservation. Based on their general measurement and quota evaluation, they have established new energy quotas and reward and penality systems via analysis. Today plants and enterprises in urban Shanghai consuming 50 tons of coal or more per month and suburb plants and enterprises with a monthly coal consumption of 10 tons or more have all established energy quota and strengthened their energy management, above-quota uses of energy are charged at an increased rate and excess consumption will not be subsidized. Since 1979 Shanghai has been working on energy management and by 1982 the gross value of industrial production was growing at an average rate of 5.9 percent, the average annual increase in energy consumption was only about 1 percent, and 2.5 million tons of standard coal were saved in the 3 years. At the Tianjin Vehicle Machinery Plant, they stressed economic efficiency and required the shops to achieve the production quantity, value of production, product quality, production cost and conservation stipulated by the plant before conservation awards can be issued.

In the scientific management of energy, the resources must be systematically and methodically surveyed so that the energy supply may be balanced between the enterprises. The actual energy utilization situation must be understood so that the necessary measures may be taken to fix the wasteful steps. In the general energy survey of industries and enterprises in Qingdao, attention was placed on the shortage of electricity and water. The first step was to identify the typical situation and accumulate some experience. The second step was to open up the conservation effort in stages and in batches and from point to the surface. The third step was to balance the supply of electricity and water at some priority locations. Based on the experience accumulated in Shanghai, enterprises that have completed the general energy survey or thermal energy valance were generally able to improve the energy utilization rate by 1-2 percent and in some cases 3-6 percent.

III. Improve Economic Efficiency by Technological Reform

Since 1982 the Anshan Steel Mill made technological improvements to conserve energy, optimized their production method and cut their wastes of energy. In the past the steel ingots were generally cooled to 600°C or so after they were removed from the mold and sent to the first rolling mill. The ingots were then heated up to 1,300°C in the furnace before rolling. This conventional method has now been improved and more than 70,000 tons of standard coal were saved every year. The Anshan Steel Mill has measured the efficiency of their rolling furnaces, blowers and water pumps and saved 25 million kWh of electricity from improvement of the 22 low efficiency blowers alone. The technical improvement approach taken by the Anshan Steel Company requires modest investment and produces fast economic benefits.

The Nanjing Chemical Plant made technological improvements to save energy in their aniline production facility and reduced their steam consumption from 62 tons to 1 ton for every ton of aniline produced and their electric consumption from 340 kwh to 130 kwh. After these improvements, they have achieved the advanced standard of similar facilities abroad and conserved 160,000 yuan of steam and electric power per year. The 230,000 yuan invested in technological improvements were recovered in 18 months. Compared to 1978, the energy consumption per 10,000 yuan of production value and the energy consumption per unit product in 1982 have respectively dropped 27 percent and 23 percent. This shows that great improvements can be made to upgrade the backward production technology.

The new model D250-150 high-pressure water injection pumps used in the Daqing oil fields improved the efficiency of the operation from 62 percent to 75 percent and saved 2.14 million kWh of electricity per year at a value of 128,000 yuan. The 70,000 yuan purchase cost of a new water pump can be recovered in less than 1 year. The model 2K60 ventilator developed by the Shenyang Blower Plant has an efficiency of 84 percent. The Beijing Mentougou Coal Mine bought a new blower and saved 190,000 kWh of electricity in one year at a cost of 17,000 yuan, which can be recovered in 2.5 years. If all the 2000 old blowers used in China's coal mines were replaced, 520 million kWh per year can be saved.

In the last few years numerous new energy conservation methods and technologies have come into existence in different areas in China. These new improvements should be actively promoted. From 1981-1982, Yunnan has modified 30,000 old Liberation model vehicles at a cost of 300 yuan per vehicle. Modifications of the four major components alone (cylinder head, oil pressurizer, intake and exhaust manifold, and distributor) saved 10-15 percent of fuel. For an 8 percent saving in fuel, the province may save 18,000 tons of fuel per year valued at 12 million yuan and the modification investments made in the 2 years have long been recovered. Using silicon-controlled governor devices, a trackless trolley may save 20 percent of its electricity consumption. There are now 3,500 trackless trolleys in China that consume 300 million kWh of electricity, if all the trolley cars are equipped with the new silicon-controlled device, one-third of the electricity consumption can be saved. In the area of new light sources, the high-voltage sodium lamp has an efficiency equal to 8-10 times of that of an ordinary lamp and twice the efficiency of a high-voltage mercury lamp. China produces 2.6 million high-voltage mercury lamps annually, if they are all replaced by the high-voltage sodium lamp, 1.5 billion kWh will be saved in a year. These are low investment and fast result items and should be systematically promoted.

Residual heat and residual energy should also be utilized in an integrated manner. The 1983 energy survey in Nanjing Municipality revealed that 132 enterprises in the city with an energy consumption of 3000 tons of standard coal or more have available to them 539 million kilocalories of residual heat and only 58 percent of it was utilized. In Wuhan, 62 enterprises that each consumed 10,000 tons of coal per year had an equivalent of 201,500 tons of standard coal of useable residual heat. At the present time only 41.2 percent is recovered and 58.8 percent left untapped. The Shanghai Solvent Plant,

a facility consuming 60,000 tons of standard coal per year, improved two of their 50,000-ton-per-year formaldehyde production facilities to produce steam with the reaction heat released in the production process and changed the formaldehyde production facilities from energy consumers to hear suppliers. The steam production per ton of formaldehyde produced has now been increased from 285 kg to 415 kg, a 46 percent increase, and the thermal efficiency of the device has been increased to 78 percent to save 5,700 tons of standard coal per year. Therefore, the utilization of residual heat and residual energy is an effective way to improve the energy utilization rate.

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